Comparative Evaluation of the Effect of Chemical and Diode Laser Activated Bleaching Techniques on Enamel Surface and Subsurface

Original Article

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ABSTRACT

Objective: The aim of this study was to compare diode laser-activated bleaching effect versus chemical bleaching on enamel surface and subsurface of human mandibular incisors concerning morphology and chemical profile.

Materials and Methods: Forty extracted human, caries and defect-free mandibular incisors were divided into four groups by dividing their labial surface longitudinally into two halves. The distal halves of 20 teeth were assigned for chemical bleaching protocol using 38% hydrogen peroxide, their mesial halves represented their control. The other 20 teeth were assigned by the same method into laser-activated bleaching group and its control. The morphology and chemical profile of the surface and subsurface of the labial enamel were investigated, chemical profile of the subsurface was investigated at 50 and 100 μm depth.

Results: The enamel surface of chemically bleached group showed surface irregularities, porosities and erosive areas, ternary diagram of its chemical profile presented a slight shift to an area of less mineralized enamel. Morphology of the subsurface of chemically bleached enamel showed structural defects in prisms configuration and channels extending from surface defects through the enamel, its ternary diagram presented a shift to a demineralized area at both depths examined. Enamel surface of laser-bleached teeth appeared as a molten glazed surface and presented almost no shift in the ternary diagram. Subsurface of laser-bleached teeth showed loss of prismatic enamel integrity and presented a shift to a more mineralized area at 50μm depth and to a demineralized area at 100μm depth.

Conclusion: Laser-activated bleaching caused less enamel surface irregularities than chemical bleaching, but its effect was more deleterious on the morphology of the enamel subsurface. Concerning enamel chemical profile, subsurface enamel of chemically bleached teeth was more affected than that of the laser-bleached teeth.

INTRODUCTION

The beauty of the smile plays a crucial role in social relations; in consequence, cosmetic dental treatments have been progressively more demanded by many persons[1] who are motivated by the increased awareness of discolored teeth provoked by the media. Bleaching; being shown within this context as the chemical degradation of chromogens, provides individuals with an attractive smile and it is considered a conservative procedure[2,3] when compared with alternative techniques as dental veneers, composite facings or full crown coverage[4].

Hydrogen peroxide (HP) is the popular contemporary bleaching agent used in-office, mainly in gel form with varying concentrations (15%-40%)[5]. It allows a controlled application on the tooth and minimizes exposure time compared with at-home dental bleaching[6]. HP, being an oxidizing agent can generate free radicals which break down the organic compounds of chromogens staining the teeth into smaller molecules or oxidize their double bonds[7]. This alters the chromogens configurations and consequently optical properties which leads to a lighter color perception[8].

Proven to be highly efficient in tooth whitening, many concerns have been complications, namely reported related to HP bleaching complications namely increased tooth sensitivity. Concerning enamel, modification in surface morphology, alteration in chemical composition, increased permeability and prominent changes in its mechanical properties were also observed[9,10,11].

Laser, considered as the instrument of choice in many dental applications nowadays[12] was reported to accelerate the bleaching reaction and to enhance the efficiency of bleaching materials[13,14,15] by increasing the free radicals of bleaching agents during the bleaching process. HP bleaching treatment activated by diode laser was suggested to prevent loss of enamel mineral composition in bovine teeth and maintain its crystalline structure when compared with conventional bleaching[16]. On the other hand, it was found to cause significant Ca and P reduction in humans[17].

The ideal bleaching procedure should bleach the tooth without causing neither morphological nor chemical changes[18]. Therefore, the present study was designed to compare diode laser-activated tooth bleaching effect

with chemical tooth bleaching on both enamel surface and subsurface of extracted human mandibular incisors by evaluating enamel morphological and chemical profile changes.

MATERIALS AND METHOD

Tooth Selection and Grouping

Forty caries and defect-free mandibular incisors were collected from the Surgery Department of the Faculty of Dentistry, Ain Shams University, they were extracted from patients with periodontal causes. Since the collected specimens were extracted teeth, the research was exempted from ethical committee approval. The collected teeth were kept in distilled water until randomly assigned into four main groups, where each tooth labial surface was divided in half longitudinally so that that each half represented a group: a tooth half was assigned for bleaching procedure and the other represented its control[3,11,19]. Each main group was further divided into two; surface and subsurface subgroups:

A. Control of chemical bleaching group: it contained the mesial labial half of twenty teeth which were covered by pink wax during chemical bleaching procedure. It was examined on its enamel surface and subsurface referred as CChS and CChB subgroups respectively.

B. Chemical bleaching group: consisted of the distal labial half of the same twenty teeth of the preceding group, they were bleached with chemical bleaching agent gel (WHITE smile, Power Whitening, Germany) containing 38% HP. Following instructions of the manufacture: a triple application of the gel for another 15 minutes was followed by desensitizing gel for 15 another minutes. This group was examined on both its enamel surface and subsurface referred as ChS and ChB subgroups respectively.

C. Control of laser activated-bleaching group: This group contained of the mesial labial half of twenty teeth which were covered by pink wax during laser-activated bleaching treatment. It was examined on both its enamel surface and subsurface which were referred as CLS and CLB subgroups respectively.

D. Laser activated-bleaching group: consisted the distal labial half of the same twenty teeth of the control laser group, they were bleached with the bleaching agent Laser white*20, BIOLASE (containing 38% HP) activated by diode laser (EPIC ® diode laser) and instructions of the manufacture were followed where a double application of the bleaching agent with laser activation of 30 s twice, followed by desensitizing gel for 15 minutes. This group was examined on its enamel surface and subsurface referred as LS and LB subgroups respectively.

All surface subgroups were investigated for SEM and chemical profile analysis at the middle third of the labial enamel surface. To detect the morphological and chemical profile alterations of the labial enamel subsurface, each tooth was fractured lingo-labially and its incisal third was discarded. Labial enamel subsurface chemical profile was investigated at 50 and 100 um depth[20,21].

So the final subgroups allocated for this study were:

1. Subgroups (CChS, ChS, CLS, LS) underwent surface examination with SEM and chemical profile analysis.

2. Subgroups (CChB, ChB, CLB, LB) underwent subsurface examination for SEM and were then further named according to depth of investigation of their chemical profile into:

   • Subgroups(CChB50, ChB50, CLB50, LB50) examined at 50 um depth from the labial enamel surface.

   • Subgroups (CChB100, ChB100, CLB100, LB100) examined at 100 um depth from the labial enamel surface.

SEM- EDXA examination

Specimens were mounted onto metal holder of FEI/ Inspect S scanning electron microscope attached with energy-dispersive X-ray analyzer (SEM- EDXA) so that the middle labial surface was observed using secondary electron LFD at 30 kV, with magnification between X1000, X2000 and & X5000 (spot size of 5-6 nm). The enamel subsurface was examined under magnification between X500, X1000 and X 2000.

For chemical profile analysis, Calcium, Phosphorous and Carbon weight % as well as Calcium/ Phosphorous ratio of the labial enamel surface and subsurface were determined for the assigned subgroups using EDAX Genesis FEI Inspect S (USA- Holland). Five randomly selected points were measured in each sample.

Statistical analysis

EDXA chemical profile results in weight% were tabulated, coded and introduced to PC using Grapher7 for windows to obtain ternary system diagrams. One-way ANOVA statistical analysis was used followed by Tukey's post hoc test when the level of significance was $p \leq 0.05$. IBM SPSS Statistics Version 20 for Windows was used for statistical analysis.

RESULTS

Morphological Results

Surface scanning electron micrographs of the two control subgroups (control of chemical and laser-activated) showed some scratches and irregularities in addition to well-defined perikymata grooves with enamel rod ends (Figure 1A). At higher magnification, few pits and some surface deposits were observed (Figure 1B).

Scanning electron micrographs of surface of chemically bleached subgroup showed an enamel surface with apparently increased surface irregularities in the form of pits, pores, eroded areas and crater-like depressions (Figure 1C). At higher magnification, many pores of different sizes were noted as well as fine eroded lines with fish scale-like appearance (Figure 1D).

The enamel surface examination of laser-bleached subgroup specimens appeared as a molten glazed surface (Figure 1E). It showed ill-defined perikymata grooves with few concavities of enamel rod ends (Figures 1E,1F).

Morphological examination of the enamel subsurface of both control subgroups (CChB and CLB) revealed several planes of enamel prisms arranged longitudinally (Figure 2A). At higher magnification, the enamel prisms appeared bulging and separated by inter-prismatic structure (Figure 2B).

Scanning electron micrographs of ChB subgroups revealed multiple surface concavities extending to various depths into the enamel, some of which were connected to channel extending into the enamel (Figures 2C,2D). On a higher magnification examination, there was no bulging of enamel prisms but some scattered defects in the form of irregular concavities were observed on individual prisms (Figure 2D).

The subsurface morphological results of laser-activated bleaching subgroups showed ill-defined enamel structure with loss of enamel architecture (Figure 2E). At higher magnification there was disappearance of the bulging pattern of individual prisms and it was difficult to identify prisms from inter-prismatic structure (Figure 2F).

Chemical profile results

After application of chemical bleaching régime on surface of chemically treated group specimens, the ChS subgroup showed a non-significant changes in the C, P and Ca wt.% in comparison with its control (CChS) (Table1, Figure 3). This was reflected in ternary diagram as a slightly shift of ChS subgroup to a less mineralized area (Figure 4).

The EDXA results of ChB50 subgroup revealed a significant reduction in Ca/P ratio when compared to its control (Table 2, Figure 5). Meanwhile ChB100 showed significant loss of P wt.% and C wt.% increase when compared with its control (Table 3, Figure 6). This was reflected in the ternary diagram as shift of both subsurface subgroups to a demineralized area (Figures 7, 8).

Comparing the chemical profile of LS with CLS subgroups, the application of laser-activated bleaching régime demonstrated a non-significant decrease in all examined mineral weight % (Table 4, Figure 9) which was reflected as almost no shift in the ternary diagram (Figure 10).

EDXA results of LB50 and LB100 subgroups in comparison with CLB50 and CLB100 subgroups

respectively showed significant decrease in the Ca/P ratio (Tables 5,6, Figures 11,12). In ternary diagram, a shifting to a more mineralized area was revealed with LB50 subgroup (Figure 13) whereas a shift to a demineralized area appeared with LB100 (Figure 14).
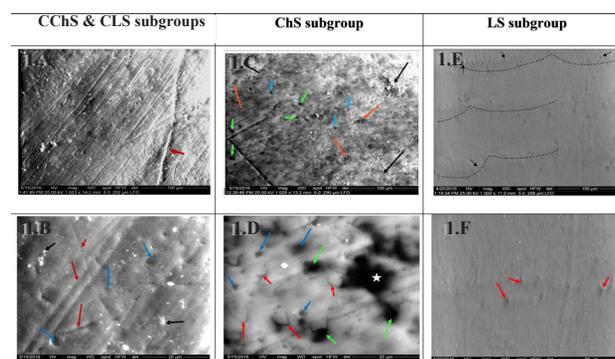

Fig. 1: Scanning Electron micrographs of enamel surface (A, C, E Original magnification X 1000) (B, D Original magnification X5000), (F Original magnification X2000).

A) CChS and CLS subgroups showing perikymata with rod end concavities (red arrow) and surface scratches.

B) Higher magnification of the previous micrograph showing scratches (red arrows), few pits (blue arrows) in addition to some surface deposits (black arrows).

C) ChS subgroup showing many surface irregularities in the form of eroded areas (black arrows), pits (blue arrows), pores (green arrows), and crater-like depressions (orange arrows).

D) Higher magnification of the previous micrograph showing eroded areas (*), pits (blue arrows), and pores of different sizes (green arrows) on the surface. Note the presence of fine eroded lines (red arrows) with fish scales shape.

E) LS subgroup showing molten –like enamel surface and ill defined perikymata grooves (dotted line) with few enamel rod ends (arrows).

F: A higher magnification of the previous micrograph showing few concave enamel rod ends (red arrows).
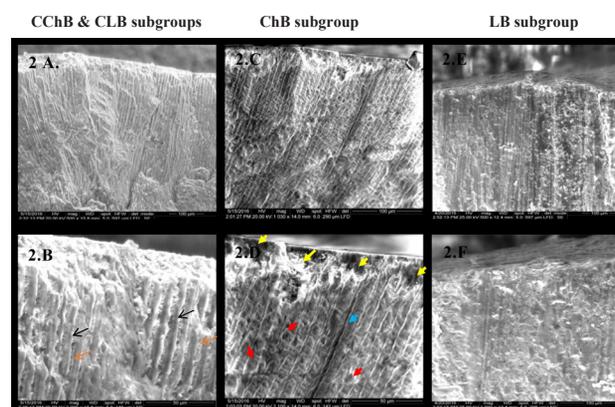

Fig. 2: Scanning electron micrographs of enamel subsurface (A, E Original magnification X500) (B, D Original magnification X2000), (C, F Original magnification X1000).

A) CChB & CLB subgroups showing different planes of parallel prismatic enamel.

B) Higher magnification of the previous micrograph showing bulging parallel enamel prisms (black arrows) and depressed inter prismatic structure (red arrows).

C) ChB subgroup showing surface defects extending to various depths into planes of parallel prismatic enamel.

D) A higher magnification of he previous micrograph showing multiple concave surface defects (yellow arrow) and absence of enamel prism bulging. Note the channel (blue arrow) extending from the surface defect through the enamel and the scattered irregular concavities on individual prism structure (red arrow).

E) LB subgroup showing loss of enamel subsurface architecture.

F) Higher magnification the previous micrograph showing ill distinguished prisms and interprismatic structure and absence of enamel prism bulging.
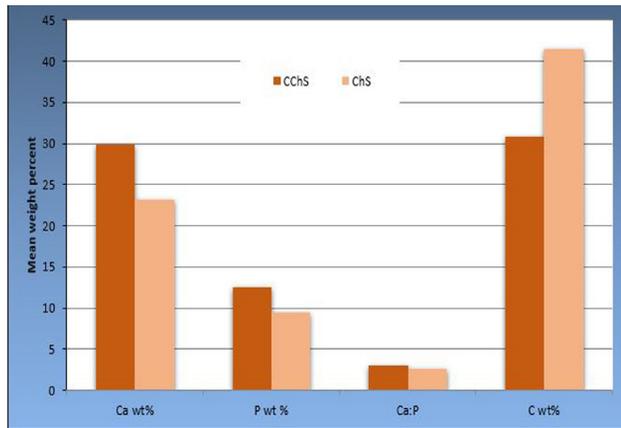
Fig. 3: Bar chart representing comparison between CChS and ChS subgroups regarding Ca, P, C wt% and Ca:P ratio.
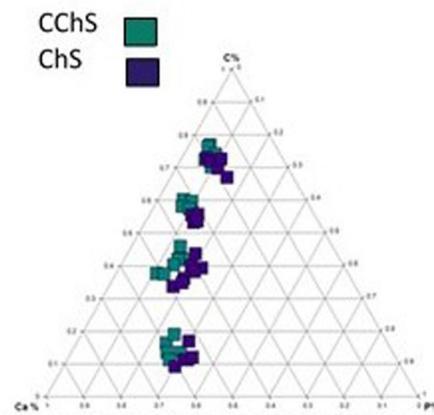

Fig. 4: Ternary diagram showing the relationship between Ca, P and C wt. % in enamel surface of CChS and ChS subgroups.
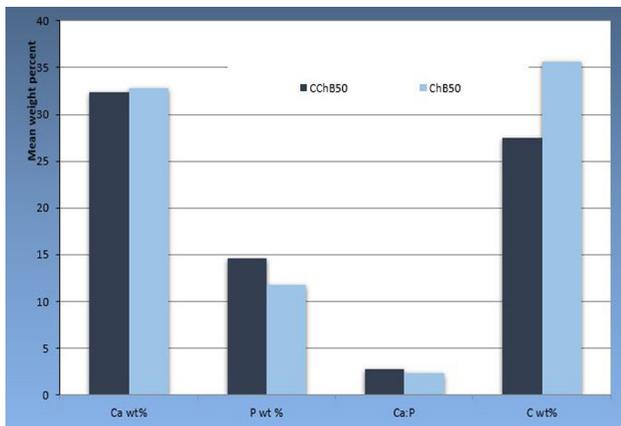

Fig. 5: Bar chart representing comparison between CChB50 and ChB50 subgroups regarding Ca, P, C wt% and Ca:P ratio.
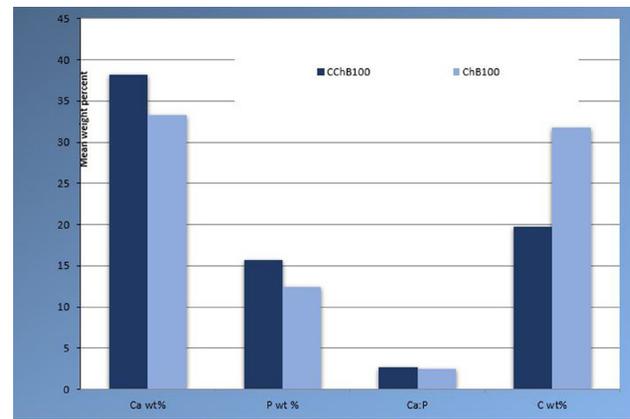
Fig. 6: Bar chart representing comparison between CChB100 and ChB100 subgroups regarding Ca, P, C wt% and Ca:P ratio
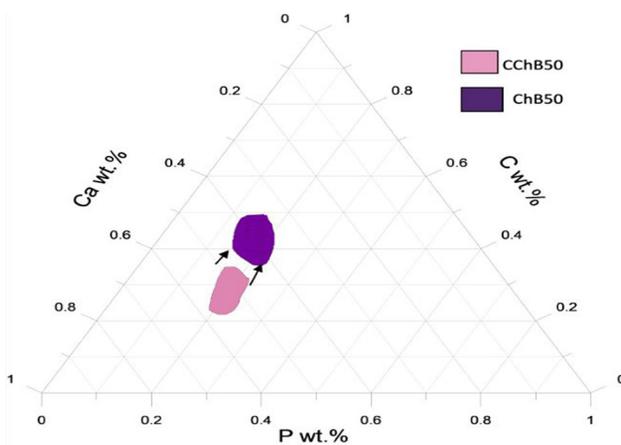
Fig. 7: Ternary diagram showing the relationship between Ca, P and C wt. % in enamel subsurface at 50μm of CChB50 and ChB50 subgroups.
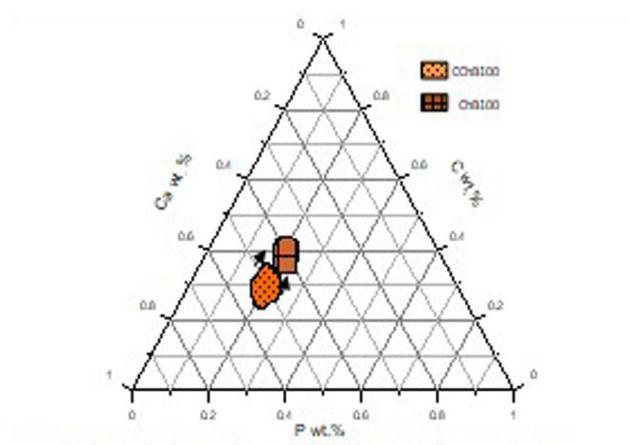
Fig. 8: Ternary diagram showing the relationship between Ca, P and C wt. % in enamel subsurface at 100μm of CChB100 and ChB100 subgroups.
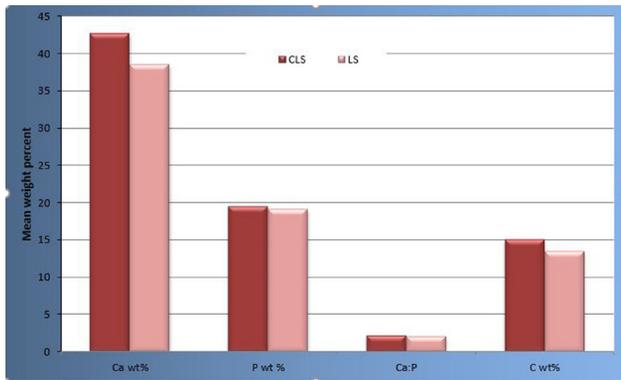
Fig. 9: Bar chart representing comparison between CLS and LS subgroups regarding Ca, P, C wt% and Ca:P ratio.
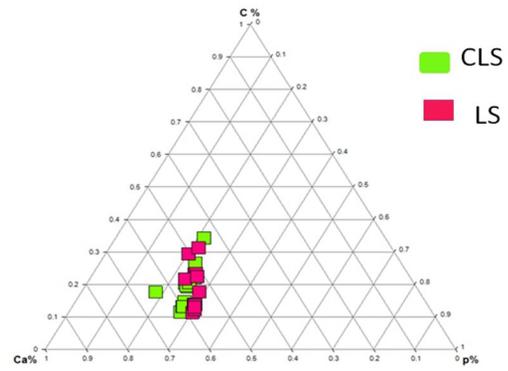
Fig. 10: Ternary diagram showing the relationship between Ca, P and C wt. % in enamel surface of CLS and LS.
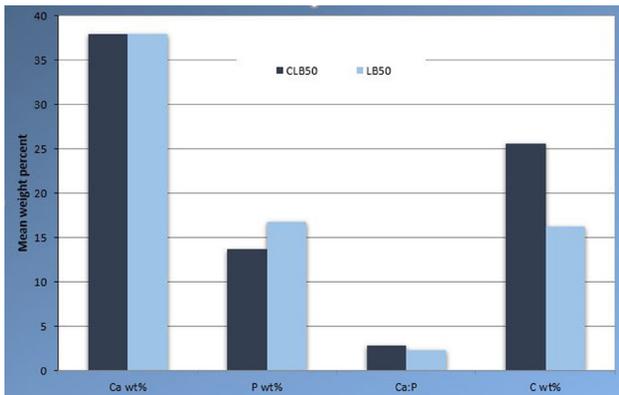
Fig. 11: Bar chart representing comparison between CLB50 and LB50 subgroups regarding Ca, P, C wt% and Ca:P ratio.
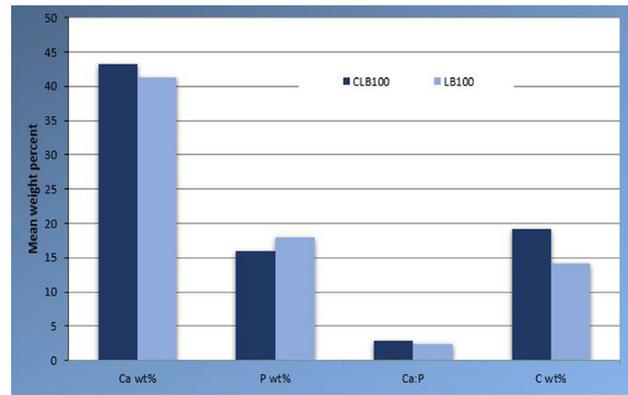

Fig. 12: Bar chart representing comparison between CLB100 and LB100 subgroups regarding Ca, P, C wt% and Ca:P ratio.
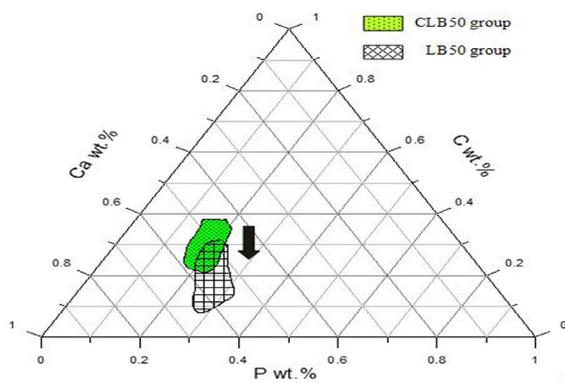

Fig. 13: Ternary diagram showing the relationship between Ca, P and C wt. % in enamel subsurface at 50μm of CLB50 and LB50 subgroups.
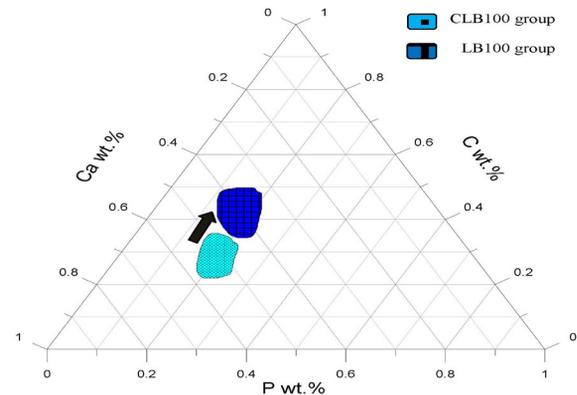
Fig. 14: Ternary diagram showing the relationship between Ca, P and C wt. % in enamel subsurface at 100μm of CLB100 and LB100 subgroups.

Table 1: The mean and standard deviation (SD) values for chemical profile recorded in CChS and ChS subgroups

Mineral	CChS		ChS		P-value
	mean	SD	mean	SD	
Ca wt%	29.8	12.0	23.2	13.5	0.500
P wt%	12.5	6.7	9.5	7.6	0.500
Ca:P	3.0	0.6	2.6	0.5	0.058
C wt%	30.9	15.8	41.5	20.3	0.345

Table 2: The mean and standard deviation (SD) values for chemical profile recorded in CChB5O and ChB50 subgroups

Mineral	CChS		ChS		P-value
	mean	SD	mean	SD	
Ca wt%	32.4	4.6	32.8	10.9	0.893
P wt%	14.6	3.6	11.8	4.4	0.225
Ca:P	2.8	0.2	2.2	0.3	0.013*
C wt%	27.5	9.9	35.6	18.9	0.686

*: Significant

Table 3: The mean and standard deviation (SD) values for chemical profile recorded in CChB100 and ChB100 subgroups

Mineral	CChS		ChS		P-value
	mean	SD	mean	SD	
Ca wt%	38.2	5.8	33.3	9.2	0.686
P wt%	15.7	2.7	12.4	4.1	0.043*
Ca:P	2.7	0.2	2.5	0.7	0.308
C wt%	19.7	5.3	31.8	12.8	0.043*

*: Significant

Table 4: The mean and standard deviation (SD) value for chemical profile recorded in CLS and LS subgroups

Mineral	CChS		ChS		P-value
	mean	SD	mean	SD	
Ca wt%	42.7	3.9	38.3	2.5	0.059
P wt%	19.4	1.2	19.1	1.1	0.508
Ca:P	2.2	0.1	2.0	0.2	0.223
C wt%	15.2	5.2	13.4	5.8	0.646

Table 5: The mean and standard deviation (SD) values for chemical profile recorded in CLB5O and LB50 groups

Mineral	CChS		ChS		P-value
	mean	SD	mean	SD	
Ca wt%	38.0	9.0	38.2	6.9	0.893
P wt%	13.7	3.6	16.8	1.9	0.225
Ca:P	2.8	0.1	2.3	0.2	0.016*
C wt%	25.6	14.9	19.2	7.3	0.646

*: Significant

Table 6: The mean and standard deviation (SD) values for chemical profile recorded in CLB100 and LB100 subgroups

Mineral	CChS		ChS		P-value
	mean	SD	mean	SD	
Ca wt%	43.2	6.8	41.2	5.8	0.173
P wt%	15.9	3.7	18.0	3.6	0.046*
Ca:P	2.8	0.9	2.4	0.7	0.025*
C wt%	19.1	7.8	14.2	9.1	0.173

*: Significant

DISCUSSION

It is well established from the literature that when elevated concentrations of HP bleaching gel were used, light-activated and non-light-activated techniques, both demonstrated comparable immediate and short-term whitening clinical results[18,22].

Nonetheless, obtaining clinical efficacy must be combined with minimization of possible side effects and still controversies exist in the literature about HP's adverse effects on enamel morphology[23].

In *vitro* models were used in this study for their significance in primary prototypes evaluation and treatment conditions optimization[24] and also to gain information on the effects of HP penetration on the enamel structure during bleaching techniques[25].

In the current study, morphological results of surface and subsurface of the chemical bleaching group revealed apparent alterations. In enamel surface, this was represented by pits, pores, eroded areas and fish scale-like erosions. Similar effects modifying the enamel surface were previously documented after bleaching with HP[11,17,26].

Generated byproducts from the oxidizing reactions of the bleaching agent were reported to cause erosions and porosities in enamel[27,28,29] as they affected directly the organic phase of the dental structure and altered its mineral phase causing tooth surface morphological changes[29]. Moreover, penetration of generated byproducts through enamel also affected its interprismatic portion[27,28]. Appearance of fish scale-like erosions on enamel surface was later explained by Nanci[30] as a loss of the interprismatic substance known to contain great organic content and less inorganic substance.

On examination of enamel subsurface of the same group, multiple surface defects were observed, sometimes connected with channels extending in between the enamel prisms, which was in agreement with other studies[11,31]. Detection of these channels could denote that HP greatly affected the enamel organic matter in the interprismatic region as explained by Jiang *et al.*[32].

The morphological results of the enamel surface of the chemically bleached subgroup were not complying with studies[33,34] that have evidenced no alterations in the morphology of enamel surface when 38% HP was applied. This discrepancy in results may be related to the in *vivo* condition in the mentioned studies, where the chemical bleaching effect on enamel might be counteracted by the re-mineralizing and the buffering effect of natural saliva[17].

In the present study, EDXA was selected to detect enamel mineral content as it is considered the most relevant technique to study elemental composition in confined small areas of mineralized enamel in a non-destructive way and also to correlate different elements distribution to its histological structure[35,36]. Enamel is a mineralized tissue carbonated at various degrees[37]. As the carbonate wt. % in the enamel apatite has a great effect on the degree of apatite mineralization[38,39], it was investigated with Ca and P in the chemical profile of this study. The ternary diagram was used to get a true image of mineralization and correlate it with the change in Ca/P ratio.

In this study, the chemical profile results of the enamel surface in the chemically bleached subgroup revealed non-significant changes in the Ca, P and C wt.% when compared with its control. This could be explained based on the fact that inside the oral cavity, exposure of enamel surface to mineral ions and fluoride promoted substitution of hydroxyapatite near the surface with fluoroapatites which are less soluble[40,41] making the enamel surface more dense and less permeable[42] to mineral diffusion than deeper layer.

Significant demineralization was recorded in both subsurface depths (50 and 100 µm) of the chemically bleached subgroup. It was suggested that due to small

molecular weight of HP, it can easily go through enamel and accordingly, changes were more expected to be observed in the enamel subsurface which contain more organic substance[29]. Organic material was reported to act as channels allowing HP to penetrate through enamel promoting deproteinisation[43]. As the protein and mineral contents of enamel are chemically linked, they are considered as one unit rather than two separate entities[44]. It was further suggested that during enamel deproteinisation, any mineral linked to an enamel protein is eliminated too. Significant demineralization of enamel subsurface was similarly reported following 35% carbamide peroxide bleaching[20].

In the current study, the molten-like enamel surface observed morphologically in laser-bleached subgroups was in parallel with results of previous studies[23,45,46] that reported that enamel surface unevenness was not increased using laser bleaching . It was previously pointed out that laser decreased the time of bleaching with minor alterations in enamel surface[47]. However, the molten-like surface observed in this study was unlike the results of studies[17,48] that reported increased porosities and loss of enamel integrity with presence of erosion and sheared enamel prisms. This controversy in results could be attributed to different methodologies, as dissimilar light sources for bleaching activation and time of activation, dissimilar tooth type or other material selected in the study. It was pointed out that modification of enamel surface after bleaching also depended on many factors related to the bleaching agent including its concentration, its contact time with the teeth and its pH[6].

In this study, SEM results of subsurface of laser-bleached subgroup showed loss of enamel integrity. Different types of lasers are supposed to cause the decomposition of enamel organic content[36,49]. De Sant'Anna *et al*.[36] suggested that laser photo-thermal reaction affected the crystalline structure of the enamel subsequent to decomposition of its organic content resulting crystals reordering and reorganization. Based on this hypothesis, it could be speculated that reordering of enamel crystals could account for the appearance of ill-defined prisms and inter-prismatic substance and the loss of enamel prismatic architecture observed in the scanning electron micrographs of the subsurface of the lased subgroups.

After application of the laser activated-bleaching regime in this study, a non significant decrease in all examined mineral wt% was recorded in enamel surface, reflected as almost no shift in the ternary diagram. This could be explained based on the assumption of Hsu *et al*.[49] that demineralization of enamel depends on its organic element besides other things, the investigators speculated that decomposition products resulting from destruction of the organic components after exposure to laser obstruct the paths of mineral diffusion. Another explanation could be related to the development of microspaces in the apatite crystals after exposure to laser due to the decrease in water and carbonate contents which could inhibit demineralization by entrapping the dissolved ions[50].

On comparing EDXA results of enamel subsurface of the lased subgroups with their control, the recorded Ca/P ratio was significantly decreased at 50 and 100 um depth which could indicate a decrease in the enamel subsurface mineralization in both lased subsurface subgroups. Surprisingly, a shift of lased subgroup to a more mineralized area was observed in the ternary diagram at 50um depth, this could be related to the changes recorded in C wt% after exposure to laser. It is worth noting that a direct relation between loss of carbonate in enamel exposed to laser and reduction of enamel demineralization was previously reported[51].

When comparing the effect of the two bleaching techniques used in this study on the enamel surface, both showed non-significant changes in their chemical profiles. Regarding morphological effects, chemical bleaching was associated with surface irregularities while laser -activated bleaching resulted in a molten-like enamel surface. Enamel surface irregularities observed after chemical bleaching were reported to increase caries susceptibility[52] and permeability allowing rapid re-staining[53]. Meanwhile, laser was reported to reduce permeability and solubility of enamel[49,54] and to increase enamel resistance to caries[55].

The observation that laser activated-bleaching produced less enamel surface irregularities than chemical bleaching is coincident with other studies[23,46]. However, it is not consistent with that of Coceska *et al*.[17] revealing that laser treatment was more aggressive than chemical bleaching on enamel surface where surface integrity was lost with shearing of the enamel rods and significant reduction of both Ca and P. This controversy in results could be attributed to the difference in the methodology as previously mentioned in the results of laser-bleached surface subgroup.

Regarding enamel subsurface, the morphological findings of this study revealed that laser activated-bleaching caused greater deleterious effects when compared with chemical bleaching, this was represented by loss of prismatic architecture of the enamel. Laser photo-thermal effect on enamel; explained in previous studies as denaturation of protein matrix and/ or disorganization of crystals was reported to be irreversible[56]. On the other hand, the effect of chemical bleaching was reported to be possibly reversed by a re-mineralizing régime[17,57]. Therefore, according to the present study findings, it was difficult to draw conclusions for the recommendation of a bleaching method over the other. Considering this in-*vitro* study limitations, in-*vivo* investigations are required to explore the obtained results clinically and to evaluate the possible reversibility of morphological and chemical alterations caused by both techniques, as well as their effect on dental pulp.

CONCLUSION

Diode laser-activated bleaching caused less enamel surface irregularities than chemical bleaching, meanwhile laser bleaching effect was more deleterious on enamel subsurface morphology than chemical bleaching. Concerning the enamel chemical profile, subsurface enamel of chemically bleached teeth was more affected than that of the laser -activated bleached enamel.

CONFLICT OF INTERESTS

There are no conflicts of interest.

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الملخص العربى

تقييم مقارن لتأثير تبييض الأسنان الكيميائى و المحفز بليزر ثنائى القطب على المينا السطحى و تحت السطحى

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المقدمة: يزداد الاقبال على تبييض الأسنان كل يوم بسبب الرغبة في أسنان أكثر بياضاً،خاصة مع انتشار تناول هذا الموضوع في كافة وسائل الاعلام. وتستند أنظمة التبييض المستخدمة حاليا في عيادات الأسنان في المقام الأول على بيروكسيد الهيدروجين بتركيزات تتراوح ما بين ١٥٪ الى ٤٠٪.

ويعتبر بيروكسيد الهيدروجين عامل مؤكسد يكون أيونات حرة قادرة على تكسير الجزيئات التى تصبغ الأسنان، فتغير خواصها البصرية وتراها العين بلون أفتح. على الرغم من أن تبييض الأسنان فعال في تفتيح لونها، الا انه اكتشفت مضاعفات لما بعد التبييض تتضمن تغيرات في شكل سطح المينا، وكذلك في تركيبها الكيميائي، وفي خواصها الميكانيكية.

ويعتبر حاليا الليزر أداة الاختيار الاولى فى كثير من تطبيقات عيادات الأسنان، ومنها تبييض الاسنان بالليزر. يهدف الليزر إلى تعزيز كفاءة مواد التبييض؛ حيث يعمل على زيادة تحريرالأيونات الحرة الى سطح الأسنان.

وعند مقارنة تبييض الأسنان المحفز بالليز بالتبييض الكيميائي التقليدي اقترحت بعض الأبحاث انه يمنع فقد التركيب المعدني فى مينا أسنان الأبقارولكنه يؤدى الى فقد كمية كبيرة من Ca و P من سطح مينا أسنان الإنسان.

ولذلك فان هذه الدراسه تهدف الي مقارنة تأثير التبييض الكيميائي والتبييض المفعل بالليزر علي مينا القواطع الامامية السفلية من خلال (١) دراسة التغيرات المورفولوجيه لسطح المينا وتحت السطح، (٢) وكذلك التغيرات الكيميائيه في نسبة المعادن خلال طبقة المينا بواسطة استخدام الميكروسكوب الاليكتروني الماسح المجهز بوحدة تحليل كيميائي دقيق بالاشعة السينية.

المواد والطرق: تم استخدام ٤٠ عينة من اسنان القواطع الفكية السفلية المخلوعة من الانسان وتم تقسيم هذه الأسنان بعد تقسيم سطحها الأمامي طوليا الى نصفين بحيث تكونت اربعة مجموعات:

١. المجموعة الضابطة للتبيض الكيميائي: هذه المجموعة تحتوي على النصف الموجهة نحو خط الوسط من الجسم من تاج عشرين سن. هذا النصف كان مغطى بالشمع الوردي اثناء عملية التبييض.

٢. مجموعة التبييض الكيميائي: هذه المجموعة تحتوي على النصف الاخر من تاج نفس الأسنان العشرين في المجموعة الضابطة للتبيض الكيميائي. تم تعريضه لعملية التبييض الكيميائي باستخدام جل بيروكسيد الهيدروجين بنسبة ٣٨٪ (WHITE smile, Power Whitening, Germany) لمدة ١٥ دقيقة، ثم وضع هلام التحسس لمدة ١٥ دقيقة.

٣. مجموعة ضابطة للتبييض المحفز بالليزر: هذه المجموعة تحتوي على النصف الموجهة نحو خط الوسط من الجسم

من تاج عشرين سن. هذا النصف كان مغطى بالشمع الوردي اثناء عملية التبييض.

٤. مجموعة تجريبية للتبييض المحفز بالليزر: هذه المجموعة تحتوي على النصف الاخر من تاج نفس الأسنان العشرين في المجموعة الضابطة للتبيض المحفز بالليزر. تم تعريضه لعملية التبييض المحفز بالليزر بتركيز بيروكسيد الهيدروجين ٣٨٪ فى العامل المبيض Laser white*٢٠، BIOLASE وتم تحفيزه عن طريق (EPIC ® diode laser). وقد تمت تنفيذ إجراءات التبييض المنشط بالليزر وفقا لتعليمات الشركة المنتجه له.

وقد تم فحص الثلث الأوسط للأسطح الأمامية لأسنان المجموعات السابقة وكذلك تم قياس نسبة الكالسيوم والفوسفور والكربون وكذلك نسبة الكالسيوم للفوسفات باستخدام الميكروسكوب الاليكتروني الماسح المجهز بوحدة تحليل كيميائي دقيق بالاشعة السينية. ثم تم كسر تاج السن عرضياً لفحص الطبقة تحت السطحية المينا بنفس الطريقة وتم قياس نسبة المعادن بها على عمق ٥٠ و ١٠٠ميكرون.

النتائج: في هذه الدراسة، بعد تطبيق عملية التبييض الكيميائي على سطح عينات مجموعة التبيض الكيميائى، أظهر المخطط الثلاثى للملف الكيميائى للمعادن التى تم فحصها تحولا طفيفا الى منطقه أقل تمعدنا عند مقارنتها بالمجموعة الضابطة، كما بينت نتائج الفحص بالميكروسكوب الاليكتروني الماسح عدم انتظام السطح بصور مختلفة مثل الحفر والنتوءات والمناطق المتآكلة.

بعد تطبيق نظام التبييض الكيميائي، أظهر المخطط الثلاثى التحت سطحى للميناعلى بُعد ٥٠ و ١٠٠ ميكرون تحولا الى منطقه منزوعة المعادن عند مقارنة كلا منهما بمجموعته الضابطة. وقد اظهرت نتائج الفحص بالميكروسكوب الاليكتروني الماسح لهذه المجموعة عيوب على السطح بعضها ينتهى بعضها بقنوات تمتد عبر المينا، كما كشفت النتائج عن وجود تجويفات في الهيكل المنشورى المكون للمينا.

بعد تطبيق نظام التبييض المحفز بالليزر ومقارنتة بالمجموعة الضابطة، ظهر المخطط الثلاثى لمجموعة سطح المينا تقريبا دون تغيير. وكشفت النتائج المورفولوجية للسطح عن ظهوره على شكل سطح منصهرمصقول.

أظهر المخطط الثلاثى لمجموعة تحت سطح المينا ، بعد تطبيق نظام التبييض المحفز بالليزر عن تحولا الى منطقه أكثر تمعدنا عند عمق ٥٠ ميكرون مقارنة بمجموعته الضابطة أما عند عمق ١٠٠ ميكرون كان التحول الى منطقة منزوعة المعادن. وأظهرت النتائج المورفولوجية تحت سطح المينا تلاشي التركيب المنشورى لمينا الاسنان، حيث فقدت المينا وحدة تركيبتها المميزة.

الخلاصة: ومن هنا نستخلص أن التبييض الكيميائي تسبب فى عدم انتظام سطح المينا الخارجى للأسنان أكثر من التبييض المحفز بالليزر والذى كانت اثاره أكثر حدة على الشكل تحت السطحى للمينا وفيما يخص التركيب الكيميائي فقد تأثرت المينا تحت السطحية للأسنان التى تم تبييضها كيميائيا أكثرمن مثيلتها في التبييض المحفز بالليزر.