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THE EFFECT OF MISWAK & ITS PROTOCOL OF PLACEMENT, ON THE STRUCTURE, MINERAL CONTENT OF CHEMICAL AND LASER ASSISTED BLEACHED WHITE SPOT

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ABSTRACT

Aim: The aim of the present study was to evaluate the change in enamel structure and mineral content of artificially created white spot lesion treated either by chemical or Laser assisted bleaching preceded or followed by miswak application

Materials and Methods: Miswak freezed dried extract was prepared from freshly cut chewing sticks. Ten human sound premolar teeth freshly extracted due to orthodontic causes were divided into two halves in a mesio-distal direction two halves. A total of twenty specimens were obtained and undergone baseline surface scanning by EDX/SEM. White spot lesion is first artificially created by immersing specimens in demineralizing solution for five days. Another enamel surface scanning by EDX/SEM were done for all specimens after demineralization. The specimens were either undergone chemical bleaching using 36% hydrogen peroxide alone or Laser assisted bleaching that is performed by same concentration hydrogen peroxide activated by diode low energy Laser 980 nm. Miswak is either placed on white spot lesion before bleaching or after bleaching. A final EDX/SEM is done after treatment.

Results: For chemical bleaching group, placement of miswak on wsls followed by chemical bleaching results in enhanced remineralization with significant increase in calcium and phosphate of bleached enamel. For Laser bleaching group, placing miswak on wsls after laser activated bleaching results in significant increase in phosphate level of bleached enamel in addition to enhanced remineralization.

Conclusion: Miswak can remineralize white spot lesion treated with chemical or Laser bleaching technique with proper protocol.

KEY WORDS: Bleaching, White spot lesion, miswak, Diode laser

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INTRODUCTION

The phase before cavitation in the progress of dental caries is named white spot lesion. It is described by subsurface demineralization areas created under an intact enamel surface. The content of mineral in the affected area is decreased, which in turn affects the translucent item of the enamel, and the color of these areas develops extra opaque white. So, initial enamel lesions or flat surface caries are also titled white spot lesions. [1]

Teeth whitening was a humble and minimal invasive process for appealing restoration of all stained teeth [2]. Many researches have been done to evaluate the adverse effects formed throughout bleaching procedures. Bleaching agents of interest include those considered for particular usage only that include elevated amount of peroxides [2]

Bleaching of the tooth construction containing white spot lesions may offer mask effect that makes the whiteness of the lesion less observable [1].

Color of tooth has been detected as an important alarm for having beautiful smile and improving the appearance. The bleaching agent can be stimulated by heat and light. Purpose of heat, light or lasers is to rise the heat of a whitening agent related to tooth surface, thus accelerating the frequency of breakdown of oxygen to into oxygen free radicals refining the relief of pigment-holding particles [3,4]. The method for activating whitening utilizing light spectrum is named photo-oxidation that is carried out by tungsten halogen machines, plasma arc lamps and lasers [5,6].

A major difference between lasers and the other light sources is that lasers emit a clear monochromatic light at a single wavelength only that decreases the risk of increasing pulpal temperature [6]. Laser bleaching process is enough to be finished with a one appointment session. Also it permit operator in centering on one or particular portion of tooth [7]. The diode laser biggest advantage was mentioned as its small size, movability, and flexible optic fibers [8].

The enamel and dentin carbon-based and mineral medium are likely affected by the whitening chemicals, providing unwanted things, for example structure alterations in addition to crystal damage. Proof demonstrations that top layer suffers fundamental alterations once subjected to various whitening chemicals conceding its configuration and shape [2]

To escape or diminish the microstructural alteration affecting enamel that accompany tooth lightening, dissimilar materials with various procedures have been tried. Typically, local fluoride application is familiar with rise the rigidity and elevate tooth surface fight to acids [2]

Siwak is an arabic word is tooth-cleaning twig made from Salvadora persica tree and is the most masticated branch of many herbal types. Currently, Siwak as being derived from herbal source is broadly used in many states across the world among muslims for their therapeutic effect [9]. Natural products as miswak, propylic and chitosan may have rehardening probability. Siwak separate is rich in calcium with a little fluoride amount. Cryodesiccation of watery siwak separate may have determined its contented of ions and thereby improved their discharge [10].

Procedure of use of miswak on WSL, either before or after chemical or laser-assisted bleaching, may affect the enamel surface morphology and mineral content or so forecast color permanence after bleaching.

Therefore, we pointed from this study to evaluate the change in enamel structure and mineral content of artificially formed white spot lesion treated either by chemical or Laser assisted bleaching preceded or followed by miswak application.

MATERIALS & METHODS

Materials

I-Miswak preparation

Miswak freezed dried aqueous obtain is made as follows:

Recently sheared siwak grinding branches were gathered from the tree of Arak in Saudi Arabia Kingdom (Islamic holy city) and recognized by an agronomist. Ten grams of dried up milled twigs were soaking in one hundred milliliter disinfected refined water for forty eight hours at 4°C. Then, the separate was subjected to centrifugation action. Then the floating material was clarified through a 0.45 millimeter semipermeable paper. The separate was cryodesiccated for seven days in a cryodesiccated apparatus (Martin Christ, Alpha 1-2 LD, Vacuubrand GMBH+ Co KG, Germany) to formula a powder. The preparation was done at the National Research Renter in Dokki [11].2 gm of the freezed dried powder is mixed with 0.25 ml of distilled water.

II-White-Fx bleaching agent from sapient dental company beaming white, LCC, Vancouver, WA 98665 USA formed of 36% hydrogen peroxide

Method

Ethical approval

The procedure of the study was approved by Beni-suef University, Faculty of dentistry. Research Ethics Committee provided the agreement digit of 11032021/HS.

Teeth selection

Forty complete humanoid premolars take out for orthodontic causes were composed from fit persons after validation an approval paper at the department of oral surgery, faculty of Dentistry. The pull out teeth were delicately rubbed of left behind rubbish and cleaned meticulously by flushing water supply. The washed teeth were checked under a stereoscopic microscope (Dino lite Pro, Anmo Electronics Corp, Taiwan) at ten magnification to reject teeth with decay, flaws and developing and constitutional imperfections in enamel. Teeth were stored in sterilized salt-water/ 0.1 thymol liquefied and frozen at 4°C till procedure. Solitary teeth with integral enamel surface were enclosed in the study. Teeth showing occurrence of fissures, ruptures, demineralization, dental fluorosis or growing shortcomings were excluded [12].

Sample preparation

Teeth were dried by air for 30 seconds. Each tooth root was separated, and the head was splitted in mesiodistal way into binary splits, consuming a gentle-speed aquatic-cool 0.25 mm diamond cut (Disco de Diamante CM02/220). Thus, dual sections from separately tooth were gained, from the facial and from the lingual surface. [13] Each single surface was coated by double layers of resistant nail paint, sendoff 3 x 3 mm box uncovered at center of the external. The enamel surface directing up and were refined with water-cool grainy paper disk (800, 1200, 1500 grit) Soflex disks (3m, USA) [14].

Study design

A total of twenty specimens from ten teeth were chosen and haphazardly separated into double main alike sets according to type of bleaching technique either chemical or Laser assisted bleaching (n=10). Every chief set is further divided into dual subsections (n=5) according to protocol of remineralization either before or after bleaching (table 1).

Scanning electron microscope/ energy dispersive x-ray examination (SEM/EDX)

The enamel exteriors of specimens from all sets were closely examined by electron microscope attached with EDXA apex Unit (Quanta FEG 250 FEI, USA) at an acceleration voltage of 30 kv.

Demonstrative micron sized photographs were took, and analysis of different elements of each enamel surface was completed.

Baseline SEM/EDX is done for all specimens before applying any treatment.

To encourage synthetic white spot lesions (WSLs), Specimens were inserted in solution to remove minerals. The sol comprised of 50 m Mol acetic acid, 2.2 m Mol CaCl2 and 2.2 mM NaH2PO4 with 4.8 pH accustomed using potassium hydroxide (KOH). The sol was changed every day throughout 96 hours. The incidence of white spot lesions was approved by vision in all the specimens by zooming lens [12].

The demineralizing solution supposedly creates subsurface demineralization, keeping an intact surface to simulate early enamel lesions, as it had a 50% saturation level of Ca and P concentration. [7]

The formed WSLs were subjected to a second SEM/EDX assessment before remineralization with miswak paste in blend with powerful bleaching (Chemical or laser activated) with different protocols after which a final SEM/EDX assessment was done.

Pre-bleaching remineralization

1-Chemical powerful bleaching

After baseline surface scanning by SEM/EDX, Miswak freezed dried aqueous extract is applied to 3 x 3 mm window of the labial surface/ lingual surface of prepared specimens for ten minutes. Following this procedure, WHITE Fx bleaching gel (Sapient pm, USA) containing 36% hydrogen peroxide was applied to the specimens once for 10 min according to the manufacturer's instruction. The gel was placed onto enamel surfaces of the samples at nearly 1.5mm thinness for 30 seconds. Following the elimination of the bleaching gel, the teeth were washed, dried out and kept through distilled water till final SEM/EDX assessment is done.

2-Laser activated bleaching

After baseline surface scanning by SEM/EDX, Miswak freezed dried aqueous extract is added to 3 x 3 mm window of the labial surface/ lingual surface of prepared specimens for ten minutes. Following this procedure, WHITE Fx bleaching gel (Sapient pm, USA) containing 36% hydrogen peroxide was added to the specimens

Tooth with added white fx was laser-irradiated with 980 nm diode laser (lasotronix diode laser, poland) using the handpice designed for single-tooth irradiation.

Light emitting diode laser (lasotronix) was regulated to emit triple times from a distance of 2 millimeter at a power of 1.5 Watt by 980 nm wavelength for half a minute in a constant manner. The input was 45 J/30 s, to 135 J/90 s for each tooth. The whitening method was recurring thrice with sixty seconds break periods [15].

At that point, the lightening cream tolerated up on the enamel external for extra five minutes [15]. Follow by the exterior of every sample was bathed to get rid of the decolorizing cream totally.

Post-bleaching remineralization

First WHITE Fx bleaching gel (Sapient pm, USA) containing 36% H_2O_2 was smeared to the showed boxes on specimens once taking 10 minutes in chemical powerful bleaching group. In laser-activated bleaching group, the same protocol mentioned before is implied. Tooth with applied white fx was illuminated as mentioned before from the same distance by the same energy for the same time with the time intervals. After amputating the bleaching gel, the teeth were washed and dehydrated. Then miswak freezed dried extract is smeared to the prepared window for 10 minutes afterwards, the specimens were kept in purified water till another SEM/EDX is done.

TABLE (1)

Study groups	Explanation
Control group	Demineralized enamel
Group 1	Miswak then chemical bleaching
Group 2	Chemical bleaching then miswak
Group 3	Miswak then Laser bleaching
Group 4	Laser bleaching then miswak

Statistical investigation:

Information was explored and presented in the formula of average & standard deviation utilizing statistical bundle for the social sciences (SPSS) IBM version 22 for windows. Evaluations between different sets were constructed on ANOVA for parametric records. The in between set evaluation was performed

Paired sample t test technique. Totally assessments were carried out at statistical significance level $P < 0.05$. Graphical illustrations of average and standard malformation information were created with Microsoft office Excel 2016.

RESULTS

Surface analysis

The control group displayed ordinary enamel structural design with fish scales form, usual prism endings and interprismatic regions. Roughly isolated regions seemed non structured and empty of prism endings (fig.1).

For the demineralized collection, the normal manifestation of prisms of fish scale seemed to be faded away by the effect of decalcifying sol that point to the suspension of crystal constituents The surface of etched enamel change with destruction of interprismatic spaces in some areas hollowing out in rod ends, rise in the interprism areas in about areas and crystals admission revealed on extra regions obliterating the rod ends (fig 2)

In case of group 1 when the miswak were added on the enamel surface before chemical bleaching, some non-consistent veneers with several granulated or spherical forms covered the original enamel external but follow up normal prismatic and interprismatic areas (fig. 3).

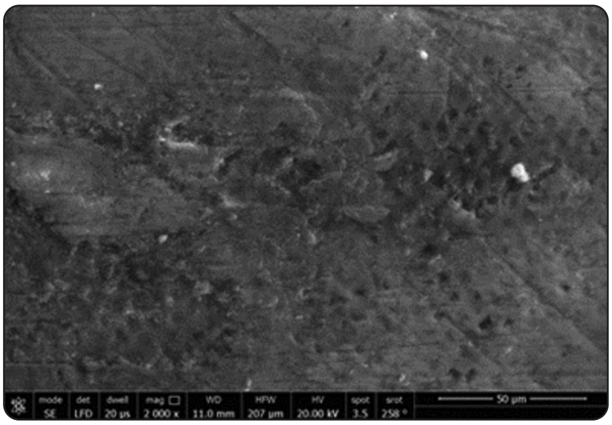

Fig. (1)

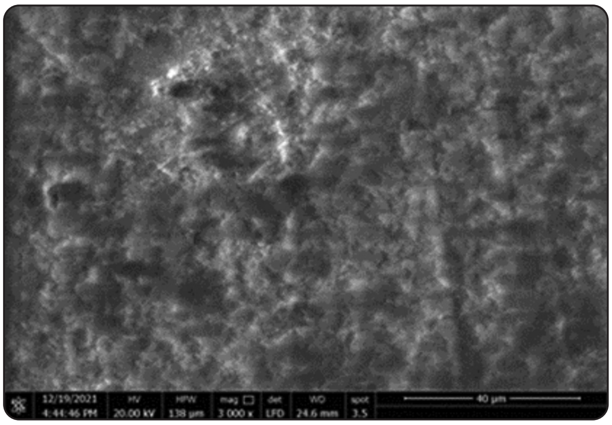

Fig. (2)

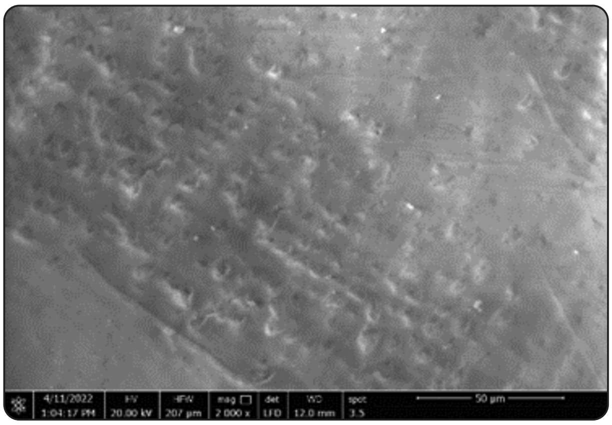

Fig. (3)

In Group 2 when miswak is added up on the enamel outward afterward chemical whitening. The granular pattern of minerals was less observable. Enamel surface showing moderate irregularities with depressions and erosions [16] (fig. 4).

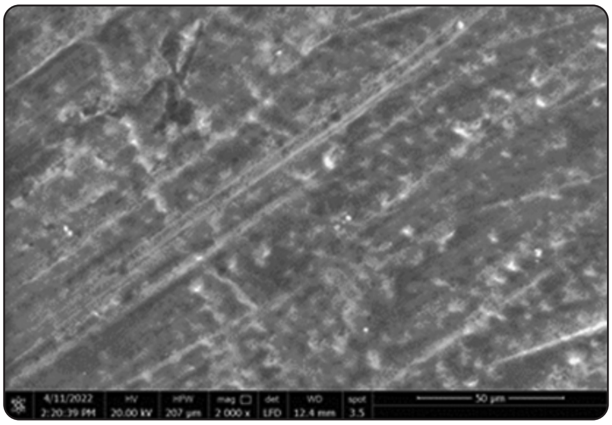

Fig. (4)

In group 3 when miswak is applied on wsls before Laser supported bleaching, the enamel surface is relatively smooth show with slight irregularities as cracks, scratches, and porosities surface founded. Characteristic enamel rod and interrod substance cannot be obviously recognized (fig. 5)

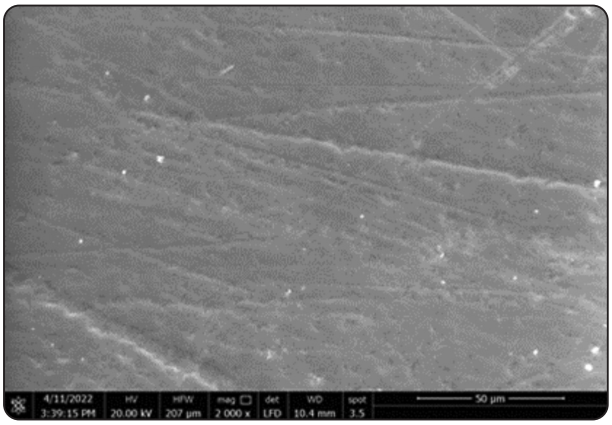

Fig. (5)

In group 4 when miswak is placed after laser supported bleaching, an observable arrival of calcium phosphate in the formula of parted or glued pellets or linear pattern was seen in association with a lesser grade of enamel surface flaws made by laser. Partial disappearance of characteristic normal enamel rod and interrod substance indicating remineralization of interrod substance. (Fig. 6).

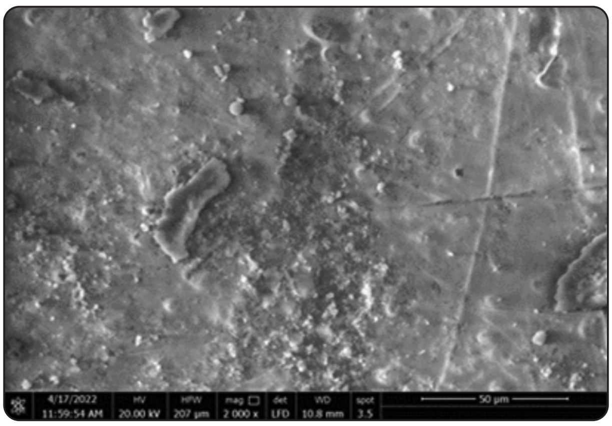

Fig. (6)

EDAX result

Energy dispersive analysis of samples revealed that the key elements from the structure of the rehardened film were Calcium, Phosphate, Oxygen and Carbon in addition to minor element Fluoride. Five measurement are engaged for each specimen for accuracy and mean for each specimen is estimated (Fig 7).

Atomic percentage of each element of Ca, P, F, C and O at each point of five points of each specimen is recorded and the mean is calculated. The mean of elements for total specimens of each group is calculated.

Comparing of the level of individual element present on the enamel exterior after either treatment exposed variances between the sets.

The mean percentage difference values of calcium and phosphorous between demineralized phase and final phases obtained from EDX analysis are shown in Table 2.

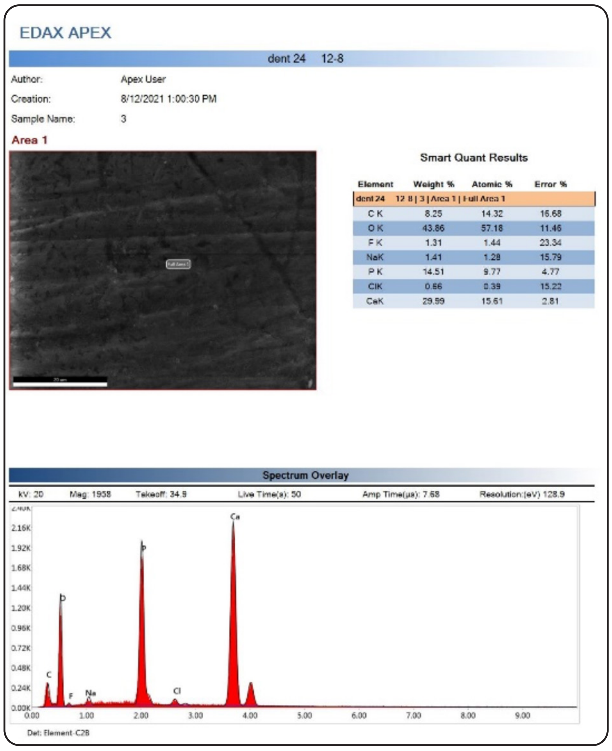

Fig. (7)

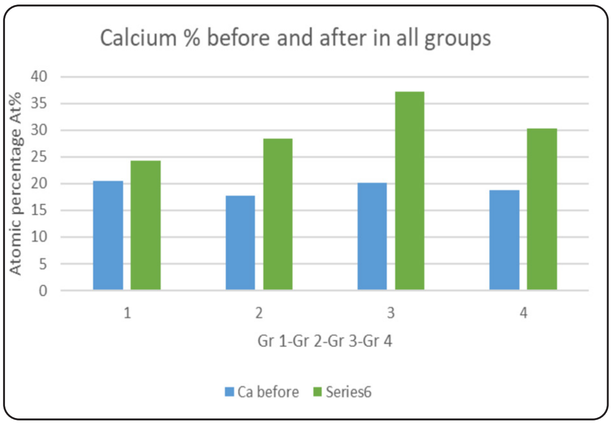

Fig. (7)

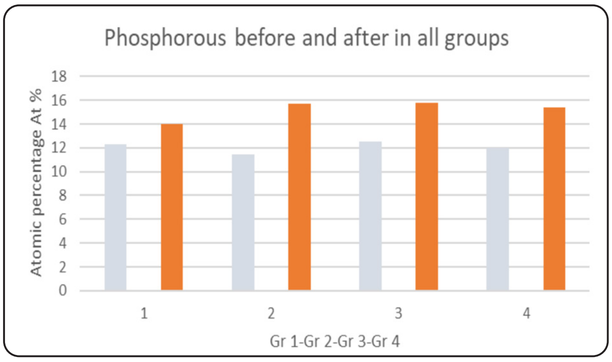

Fig. (7)

TABLE (2)

Before treatment	gr.1ca	gr.2ca	gr.3ca	gr.4ca
Mean	20.4240	17.7647	20.2107	18.7987
Standard deviation	3.74307	.22415	2.76948	.77887

After treatment	gr.1ca	gr.2ca	gr.3ca	gr.4ca
Mean	24.3133	28.4300	37.1627	30.3133
Standard deviation	.13051	3.91968	10.07844	6.11626

Before treatment	gr.1P	gr.2P	gr.3P	gr.4P
Mean	12.2860	11.4037	12.5320	11.9700
Standard deviation	1.13462	.24137	1.06040	.29280

Before treatment	gr.1P	gr.2P	gr.3P	gr.4P
Mean	13.9867	15.6733	15.7407	15.3787
Standard deviation	.17616	1.08542	2.71845	1.42976

DISCUSSION

Proper knowing the caries process has changed the universal approach against this advanced subsurface mineral loss towards protection of tooth structure by fulfilling either subsurface mineral gain or restoration of wound body structure. Break for the nasty restoration sequence and escape cavity formation [17]

White spot lesions (WSLs), described as "white dullness," happen because of subsurface enamel mineral loss that is positioned on smooth external of teeth. The reason of its dull look is the deviations in light dashing that change the visual assets of the demineralized enamel [18]

Currently bleaching is an informal, traditional technique to increase beautiful look in comparison with other processes such as plating or capping [19]. It should be considered that the bleaching manner only improves the beautiful look with a hide effect on WSLs and does not treat the lesion [1]

Whitening of living teeth can be commonly fragmented into dual theories; the application of lesser concentrations of carbamide peroxide (CP) on specially constructed trays by the patient and the application of greater concentrations of hydrogen peroxide (HP) in a dental visit [20].

Hydrogen peroxide (H_2O_2) is the peak bleaching agent in common and its level governs the manner of use. Whitening chemicals with elevated concentrations of H_2O_2 (25–40%) are used for in-office techniques. The way of bleaching agent affect teeth remains difficult to understand. It has been guessed that when the particles of H_2O_2 of the decolorizing gels penetrate the enamel distance and yield free radicals, which are extremely unsteady as they have single or extra unpaired electrons in their minute orbital. To alleviate their molecular structure, they accomplish to gain an electron from the succeeding complexes acting as powerful oxidizing means [21]

In-office bleaching is measured as a speedy treatment and it should not denote a danger to the enamel surface mineral deposits [2]. Countless investigation showed that loss of mineral results in a diminution in enamel micro rigidity following lightening with great concentration of hydrogen peroxide [22]

In latest years, lasers of numerous wavelengths such as CO2, Er: YAG, erbium, chromium: yttrium–scandium–gallium–garnet (Er,Cr:YSGG) and diode have been expended to fasten the response. The value of laser motivation for tooth bleaching is linked to conversion of energy emitted by Laser into heat. Laser energy is responsible for the discharge of hydroxyl radicals and this rises the dissemination depth of the bleaching mediator. So, the time of applying declines while the effectiveness of treatment proliferates. [23]

In-office bleaching treatments is nowadays use KTP laser, argon, and diode lasers. Diode laser is a laser generated from solid active medium which is factory-made

Since semiconductor crystals using some mixture of aluminum or indium, gallium and arsenic, The most related lasers of this group are both gallium-aluminum-arsenide laser (810 nm) and the indium-gallium -arsenide- phosphide laser (980 nm). They work in constant mode and/or pulsated modes. They have a relatively reduced absorption capability in the locality of hard constructions, soft-tissue surgical procedure can be securely done in near closeness to enamel, dentin, and cementum. [24]

Sound premolars, extracted for orthodontic purposes, were selected for this study due to their availability [13]. To get enamel rods with the matching leanings, the fragments always match up to the central area of the Buccal or lingual crown surface [25, 27].

Siwak separate has many biological properties as significant anti-bacterial influence, antifungal influence, antioxidant influence and anti-cariogenic influence chiefly through uplifting plaque pH after a sugar flush [9]. It is selected as an examples of natural remineralizing products [10] that found to be more effective in remineralizing enamel lesions than sodium flouride (NaF) in a previous study. They have different level of calcium and phosphate in addition to fluoride.

Energy Dispersive X-rays Analysis is a micro-investigative method that is used in combination with SEM to quantitatively evaluate the totals of mineral in a particular tooth sample. The EDAX x-ray detector estimates the number of released x-rays against their energy. The x-ray energy indicates the element from which the x-ray was produced. A range of the energy against relative counts of the detected x-rays is attained and gauged for qualitative and quantitative resolves of the elements that is in the specimen utilizing computer based program [26].

The middle of crown was chosen for the tested boxes to sidestep both the boosted fluoride surfaces of gingival enamel and the cheap fluoride surfaces at the coronal one third, the last one being due to the loss of original surface by attrition [27]

As previously described about structure of enamel, hydroxyapatite (OHAp) structure is being controlled by big phosphate ions organized in sheets of crowded hexagons. The minor calcium and hydroxyl ions lies in the gaps between the phosphate ions, causing only slight alterations in the hexagonally crowded phosphates. The inherent steadiness of the phosphate packing might resulted in the capacity of the apatite matrix to house switches for the calcium and hydroxyl ions [28].

Another feature of OHAp formation is that the anionic constituents, PO_4^{-3} and OH-, are unusual to undergo ionization at physiological pH. Additional plentiful molecules must be deprotonated to create these ions.

Phosphate is in state of equilibrium depending on pH among three anionic species.

As pH rises, increased amount of the phosphate is existent as $PO4_{-3}$.

Fluoride ions replace for hydroxyl ions and hydrogen-bond with adjoining OH" ions. Fluoride ions may attached to enamel proteins and rise their affinity for calcium.

The existence of low-level fluoride affects the conversion of hardly stable, extra soluble mineral phases (dicalcium phosphate dihydrate [DCPD], octacalcium phosphate [OCP], tricalcium phosphate [TCP]) to high stable, reduced soluble mineral phases (hydroxyapatite [HAP], fluorhydroxyapatite [FHAP], fluorapatite [FAP]).

In case of availability of great amount of fluoride, calcium fluoride will be formed, and if acid phosphate or phosphate ions are present, calcium fluoride can hydrolyze to form partially fluoridated hydroxyapatite (FHAP).it would be likely that fluoride would boost change of soluble, less steady mineral phases (DCPD, OCP, TCP) to less soluble, more steady mineral phases (HAP, FHAP, FAP) [26]

Furthermore, fluoride is further operational in stopping hydroxyapatite dissolution when calcium and phosphate ions are also in solution. With fluoride accessibility, demineralization is diminished because portion of the calcium and phosphate missed by the dissolution of hydroxyapatite regained by the enamel as extra acid-resistant fluorapatite [29].

The developing orders of enamel crystallites include a weighty amount of acid phosphate into the framework which is converted to "Po_4^{-3} lately". This hint advocates OCP precursor formation, while it can also be explained by the formation of an apatite lattice that drops protons and increases its crystallinity.

So, significant increased $Po4_{-3}$ ion indicates new growing tips of enamel crystallites to repair and replace lost minerals evoked by demineralization or improving crystallinity in addition to increase pH created by the remineralizing material media that assist that more phosphate to be present as $Po4_{-3}$ to be ready to be included in OHAp formation. The presence of large number of Ca^{+2} facilitate also OHAp formation.

Ca_{10} $(PO4)_6$ $(OH)_2$ a one component cell (or smallest repeating assembly) of calcium hydroxy-apatite. Ten calcium ions are needed, while six phosphate and two hydroxyls are incorporated. The relatively increased count of calcium ions makes the creation of hydroxyapetite predominantly sensitive to the calcium loss or gain of the enamel fluid (28).

Miswak has been discovered of its ability to elevate plaque pH following sucrose consumption in addition to its content of calcium, phosphate and flouride. (30)

So this explains why miswak should be placed on white spot lesions first before chemical bleaching that results in significant increase in both calcium and phosphate ions in addition to fluoride favoring remineralization. This minimize the bad effect of chemical bleaching agent on dental enamel.

Bleaching materials can cause structural changes in enamel, including dissolved organic and inorganic components, as well as changes in enamel morphology in the form of porosity, crater, depression, increased enamel depth, loss of aprismatic layers, and uneven surface of enamel such as peaks and valleys. (31)

The effect of the bleaching agents was described as the release oxygen radicals affect inter and intra prismatic structure of the enamel, providing moderate de-proteination so that any minerals associated with proteins are removed as well. This may explain the loss of calcium and phosphate from enamel when subjected to bleaching regimen increasing in the enamel microporosities.

Histologically, while the appearance of the demineralized enamel has been formerly described as composed of tinny and asymmetrical enamel prisms with hazy outlines and large inter-rod areas, SEM photo-micrographes of bleached enamel with HP bleaching agent were un-uniformly mineral depleted and loss of uniform structure of enamel. Erosive lesions are realized in prismatic enamel as characteristics pattern of demineralization with dissolution of prism cores and interprismatic substances giving honeycomb appearance. While in bleaching with agent comprising fluoride, the morphological changes were minimal presented as surface discontinuity (32).

The enamel crystals after exposure to bleaching materials with 35% hydrogen peroxide were showed that crystal form to be irregular and some crystals grew in the direction of a axis instead of c axis. Generally, the enamel crystals are covered by proteins. Once the exposure time of the bleaching material can partially remove protein so that crystal surface is exposed (30).The also possible explanation for enhanced mineralization may be due to that the micro porosities formed by bleaching on the subsurface area offers vulnerable zones for re-deposition of these materials with advanced mineral content, similar to that which happen in arrested caries (19).

The diode laser compared to high power laser considered safer regarding to their effects on enamel surface morphology, had less hazard effect on the tooth structure, less cracks, less rough enamel surface, which can make the tooth less susceptible to adhesion to bacterial plaque and acid, and less liability of pulp necrosis occurring where it is temperature not rise more than 50°C. (27) Intrapulpal hotness of more than 5.5°C will root irreversible pulpal injury (24).

Reduction of enamel solubility following only laser treatments is related to modifications in the substructure, such as water and carbonate content fall, rise in hydroxyl ions, pyrophosphates creation, and protein decay (12).

Alternative option would be to change and feasibly terminate the organic matter in the interrod space and generate such small spaces that can act as places of admission of ions and formation of grainy, bulbous particles, shapeless regular crystals organized on the enamel surface [27] .

Diode Laser-Activated Bleaching was investigated. The purpose of in office whitening is to lighten the tooth in efficient way by attaining controlled temperature raise, but without morphological and chemical alterations of enamel. The heat element is needed for speeding the speed of reaction but critical for preserving pulp well-being. In a previous study, it was found that selective diode laser radiation can decline the bleaching time with no surface change [33].

A recent study tested the efficacy of diode laser irradiation in avoiding enamel harm caused by bleaching with no remineralizing material is used. Laser increase in the nonstoichiometric apatite phase of enamel This either indicates growth in the size of apatite crystals on the a axis after laser-activated bleaching or a rise in their crystallinity (probably because of the elimination of proteins committed to apatite plates which limited them to propagate in certain directions, allowing the apatite crystals to grow in all directions [15].

Diode laser can decrease or stop the surface loss of the enamel. This might be attributed to the full-depth action of the laser-activated bleaching agent, in judgement to the undefined effect of non Laser bleaching on the surface and depth. The efficacy of bleaching also grows (less heat), which is another benefit for this technique with low post whitening sensitivity [16].

This study involves an enhanced interaction of the conventional bleaching gel with diode laser compared to the interaction of laser with the used laser-activated gel and hence a well removal of committed proteins. This study showed that conventional bleaching gel with no chromophores capable of absorbing diode laser resulted in elevated mineralization and crystallinity after being laser treated [15].

This entails that the laser effect on the enamel surface is not only because of the chromophores present in laser-activated gels, but it might also have uninterrupted effects on the enamel structure irrespective of the used bleaching agent being boosted for laser absorption or not, [15]

Diode laser bleaching combined with different remineralizing agents has higher effectiveness in achieving an increase in the bleached enamel's microhardness, improving enamel's morphology, and improving the content of calcium and phosphorus [16].

This was agreed with the increased mineral deposition observed in SEM when miswak was applied after Laser bleaching.

In element analysis of enamel surface of same group when miswak was applied after diode Laser activated bleaching, highly significant elevated phosphate ion was confirmed.

This was agreed with three studies [13, 16, 34] which demonstrated that therapeutic laser by itself is capable of achieving favorable results, remineralization of the enamel surface regarding calcium ion and a minimum but significant increase in phosphorus ions.

This predicts new growing tips of enamel crystallites or increased crystallinity aided by mineral content & high pH of miswak.

When miswak is placed on wsls followed by Laser bleaching, no significant increase in phosphate ion with no obvious remineralization as the enamel surface might be affected by hazards of Laser energy as cracks and porosity that may counteract the effect of miswak in remineralization

CONCLUSIONS

Within the limitation of the study

1- Miswak is efficient in remineralizing wsl and to guard against hazards of bleaching provided that applied with proper protocol.

2- Diode laser bleaching combined with miswak has higher effectiveness in achieving an increase in the bleached enamel's microhardness, improving enamel's morphology, and improving the content of calcium and phosphorus.

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