

# Side Effects of Dental Tooth Whitening: Data from Literature

Saimir Heta, Ilma Robo, Emela Dalloshi, Nevila Alliu, Vera Ostreni

**Abstract**—The dental whitening process, beyond the fact that it is a mini-invasive dental treatment, has effects on the dental structure or on the pulp of the tooth where it is applied. The electronic search was performed using keywords to find articles published within the last 10 years about side effects, assessed as such, of the minimally invasive dental bleaching treatment. The aim of the study was to evaluate the side effects of bleaching based on the percentage and type of solution used, where the latter was evaluated on the basic solution used for bleaching. The side effects of bleaching are evaluated in selected articles depending on the method of bleaching application, which means it is carried out with recommended solutions, or with mixtures of alternative solutions or substances based on Internet information. The dental bleaching process has side effects which have not yet been definitively evaluated, experimentally in large samples of individuals or animals (mice or cattle) to arrive at accurate numerical conclusions. The trend of publications about this topic is increasing in recent years, as long as the trend for aesthetic facial treatments, including dental ones, is increasing.

**Keywords**—Teeth whitening, side effects, permanent teeth, formed dental apex.

## I. INTRODUCTION

THE basic element in determining the color of the teeth is related to the dental structures: dentin, which has a genetically inherited color, and enamel, which is transparent, located on the dentin, reflecting the color of the latter. Younger patients have thicker enamel in cross section and enamel transparency is more reduced than in older patients. The increase in the contrast of the tooth color to the structures of the surrounding facial tissues is another element that affects the whiter appearance of the tooth compared to what it really is [1]-[3]. Another element that is added to the tooth color picture is the transparency of the enamel. Depending on the food diet, the enamel may lose its transparency locally in areas, or as a whole of the entire tooth or teeth. A high-pigment, low-fiber diet makes it possible to fix pigments in mechanically abraded cavities on the enamel surface. These cavities should not be expected to be visible to the naked eye, but are random scratches over time on the enamel surface, caused by sharp or rather rough parts of the food diet or specific foods consumed [3]-[8]. The presence of chromogenic bacteria such as *Porphyromonas gingivalis* and *Prevotella intermedia* as a normal part of the individual oral flora, also takes orientation in the positioning, as these bacteria prefer the entry of the gingival sulcus, also orienting the positioning of the specific staining of

the tooth caused by these bacteria [9]-[12].

The extrinsic staining caused by Nasmythe membrane remnant stains orients this type of staining depending on age. These colors are those reflected in the initial moments of teeth eruption, both temporary and permanent teeth [13]-[15]. Existing restorations, gingival bleeding and the routine of food selection included in the patient's individual diet are the factors that influence the appearance of discolorations inside the enamel structure. Depending on the pigmentation of these elements, the pigmentation of the tooth color is also expressed. Chromogenic foods such as black tea, wine, Coca-Cola, coffee and even specific medications can cause stains on tooth surfaces, but without the visible presence of bacterial plaque. Here is only the fixing element, without any specific chemical connection [1], [5], [16]-[22]. The other element that can give internal colors to vital teeth is the excessive presence of fluoride in drinking water, which is associated with the appearance of fluorosis [22]-[27]. This factor causes white to yellow colors, the severity of which depends on the dose of fluoride, the rate of its intake and the duration of its application in the individual diet. The next factor for the internal colors of vital teeth is hypocalcification, which is caused by enamel or dentin defects as a result of trauma without the local possibility of calcification, during tooth development; or decalcification after tooth eruption due to poor local hygiene, or local dental interventions. Vital teeth change their color, passing to a darker shade of the initial color, as a result of the aging process [28]-[32].

This study aims to collect the latest data about the side effects of whitening, as a mini-invasive dental treatment, published data on advantages, disadvantages, indications and contraindications about these procedures [32]-[37]. Tooth discoloration has different etiology, divided and classified depending on the source of the cause: as discoloration from the inside of the tooth structures and discoloration from the outer surface of the tooth. The color of the teeth has, among the artistic elements of the evaluation, an influencing element in the aggravation or not of the clinical situation, such as the age of the patient and the food diet they apply [38]-[45].

Considering all these elements, the goals of the study are: the evaluation about the method of application and the type of whitening selected by patients or indicated by the dentist himself, but also the side effects of bleaching as an aesthetic procedure, with a relatively short duration. Achieving the aim

Saimir Heta is with University Hospital, Pediatric Surgery, Pediatric Surgeon, Tirana, Albania.

Ilma Robo is with University of Medicine, Faculty of Dental Medicine, Department of Therapy, Tirane, Albania (e-mail: ilmarobo@yahoo.com).

Emela Dalloshi is with Dental Clinic, Tirana, Albania.

Nevila Alliu is with University of Medicine, Tirane, Albania.

Vera Ostreni is with Department of Morphology, University of Medicine, Tiranë, Albania.

of the study is carried out by the appropriate selection of key words and the collection of articles necessary to reach conclusions [45]-[48].

## II. METHODS

At this stage, 25 articles were selected as part of the basic articles included in the study [48]-[77].

Below are presented the data after processing the information gathered from the selected articles. Table I shows the distribution of articles based on the years of publication.

TABLE I  
TYPE OF STUDY ACCORDING TO YEAR OF PUBLICATION AND SUBJECT OF ARTICLE

Year of Publication	2012-2015	2016-2019	2020-2022	Total
Review	-	4 (14%)	-	4 (14%)
<i>In vitro</i> in animals	-	-	4 (14%)	4 (14%)
<i>In vivo</i> in animals**	-	-	3 (10%)	3 (10%)
<i>In vitro</i> in humans	3 (10%)	5 (17%)	2 (7%)	10 (34%)
<i>In vivo</i> in humans	3 (10%)	3 (10%)	1 (3%)	7 (24%)
Questionnaires	-	-	1 (3%)	1 (3%)
Total	6 (21%)	12 (41%)	11 (38%)	29*** (100%)

\*The electronic search was carried out for the period of 2012-2022, the division was carried out in 4-year time intervals, except for the last interval.

\*\*Animal experiments were performed on rats and cattle, thus exploiting the similarities in the dental structure of these animals with the dental structure of humans.

\*\*\*The total of articles collected is 25 articles, but four of them evaluate the effects of bleaching both *in vivo* and *in vitro*, this without difference in animals [74] as well as in humans in cases of bleaching applied to teeth scheduled for extraction [52], [56], [63].

The way the whitening material acts on the surface where it is applied can be classified according to the action that this material exerts on the surface of the enamel. This in our study is divided according to the categories of chemical effect, physical effect, or the combination of both physical-chemical effects. This type of classification was caused by the review article included in the criteria of the study conducted in 2019 by Epple et al. [48]. The chemical effects of the whitening material include: the protease or protein degrading effect, the solvent effect or the removal of hydrophobic compounds from the tooth surface, the oxidation-reduction effect, photochemical or interactions under the effect of light.

The physical effects include: abrasive effect or mechanical removal of surface colors, anti-deposition agent effect or removal of chromophore deposits, penetration or introduction of bleaching material depending on the component grains and their sizes, infiltration or the same as above accompanied by the process of wetting, photocatalytic or dissolution under the effect of light. The physicochemical effects include: diffusion, which is seen as a combination of infiltration but under the effect of concentration, allowing substances to move from areas of higher concentration to areas of lower concentration.

Table II shows the distribution of the articles included in the study depending on the effect obtained in the analysis of the bleaching material, the study in question was carried out and the conclusions were drawn from the data.

Table III summarizes the side effects of tooth whitening analyzed in the articles selected in the study, dividing these

effects according to the type of article (review, *in vitro*, *in vivo* or questionnaire) and the evaluation method (positive or negative). It is important to note that the positive assessment means that the article concluded that dental bleaching has a negative effect on dental structures. The negative evaluation means that the article concluded that bleaching and bleaching materials do not damage the dental structure. Among the side effects mentioned in the selected articles are: sensitivity, abrasiveness of the enamel surface, pulpal inflammation, pulpal inflammation together with abrasiveness, sensitivity together with abrasiveness, gingival irritation and the effects that bleaching has on the blood formula. At this moment, the division of the articles is carried out with the subdivisions *in vitro* and *in vivo*, regardless of where the evaluations were carried out in animals or in humans depending on the type of material used.

TABLE II  
TYPE OF ARTICLE AND THE TYPE OF EFFECT OF THE BLEACHING MATERIAL

Effect type	Chemical	Physical	Physicochemical	Total
Review	2 (7%)	2 (7%)	-	4 (14%)
<i>In vitro</i> in animals	2 (7%)	-	2 (7%)	4 (14%)
<i>In vivo</i> in animals**	2 (7%)	-	1 (3%)	3 (10%)
<i>In vitro</i> in humans	4 (14%)	3 (10%)	3 (10%)	10 (34%)
<i>In vivo</i> in humans	3 (10%)	2 (7%)	2 (7%)	7 (24%)
Questionnaires	-	-	1 (3%)	1 (3%)
Total	13 (45%)	7 (24%)	9 (31%)	29

TABLE III  
SUMMARY OF SIDE EFFECTS CAUSED BY THE BLEACHING PROCEDURE, ANALYZED IN THE SELECTED ARTICLES IN THE STUDY

Article type	Review	<i>In vitro</i>	<i>In vivo</i>	Question	Total
Sensitivity	1 (3%)	1 (3%)	2 (7%)	1 (3%)	6 (21%)
Abrasiveness	6	3 (10%)	2 (7%)	-	9 (31%)
Pulp inflammation	3 (10%)	1 (3%)	-	-	4 (14%)
Pulp inflammation	1 (3%)	1 (3%)	-	-	2 (7%)
Abrasiveness	1 (3%)	-	-	-	1 (3%)
Sensitivity	1 (3%)	-	-	-	1 (3%)
Abrasiveness	-	1 (3%)	1 (3%)	-	2 (7%)
Gingival irritation	-	1 (3%)	1 (3%)	-	2 (7%)
The blood	-	-	1 (3%)	-	1 (3%)
Glass ionomers**	-	1** (3%)	-	-	1** (3%)
Total	4 (14%)	14 (48%)	10 (34%)	1 (3%)	29 (100%)

\*\* Article numbered twice. The summary of the data of Table III is presented in Table IV, where the opinions on the appearance of negative effects and positive effects of the whitening material applied to the surfaces of the teeth are shown in total in percentage.

Table V divides the articles depending on the sample of teeth, blocks of teeth, or patients included in the experiment, clinical application or in the questionnaire, having the logic that the larger number of inclusions in the study shows clearer results with real effects of bleaching material or bleaching technique

applied.

TABLE IV  
 SIDE EFFECTS IN CASES OF APPLICATION OF DENTAL TREATMENT OF TEETH WHITENING

Effect type	Negative effects	Positive effects	Total
Review	2 (7%)	2 (7%)	4 (14%)
<i>In vitro</i>	10 (34%)	4 (14%)	14 (48%)
<i>In vivo</i>	6 (21%)	4 (14%)	10 (34%)
Questionnaire	-	1 (3%)	1 (3%)
Total	18 (62%)	11 (38%)	29 (100%)

TABLE V  
 DISTRIBUTION OF ARTICLES DEPENDING ON THE SAMPLE OF TEETH

Sample size	Case report	≤ 50 elements	≥ 51 elements	Total
Review		3 (10%)	1 (3%)	4 (14%)
<i>In vitro</i>	1 (3%)	8 (28%)	5 (17%)	14 (48%)
<i>In vivo</i>	2 (7%)	6 (21%)	2 (7%)	10 (34%)
Questionnaire			1 (3%)	1 (3%)
Total	3 (10%)	17 (59%)	9 (31%)	29

### III. DISCUSSIONS

Smoking is thought to be a factor that affects the appearance of external tooth discoloration. This depends on the type of smoking, frequency and duration of the habit [7], [33], [34]. If whitening is classified depending on the teeth where it is performed, whitening of vital teeth or non-vital teeth, even the side effects of these whitening procedures, which are performed at home or near the dental chair, can be classified and ordering according to this logic. Medium-grade sensitivity in vital teeth, post bleaching procedure in dental clinic conditions, is known to occur post treatment, as hydrogen peroxide has the ability to easily pass through enamel and dentin, but does not cause damage to the pulp. For this sensitivity, it is indicated to give analgesics with a mild to moderate effect to the patient, since it is a sensitivity that lasts a maximum of 24 hours after bleaching [1]-[5].

For the whitening of vital teeth in home conditions, the sensitivity of the teeth and the irritation of the gums are mentioned as side effects, both side effects that come as a result of the application of the whitening material in excess. In any bleached tooth, regardless of the bleaching technique applied, there is reduced temporary bonding potential between the bond and the composite. Residual oxygen from the remains of peroxide prevents the fixation of the connecting bond [1]-[6]. This is prevented by performing all conservative therapeutic dental restorations, 1 week after the last teeth whitening procedure, i.e., 1 week after the whitening is completed.

Whitening of vital teeth in the conditions of the dental clinic as a side effect mentions the color change and loss of integrity of the PMMA polymethyl methacrylate restorative material during exposure to carbamide peroxide. Therefore, temporary crowns are best modeled with bis-acrylates.

For internal bleaching, in teeth previously treated with endodontic treatment, i.e., in devital teeth, the literature reports [1]-[6] a 1% chance of cervical resorption, especially in cases of bleaching with thermocatalytic techniques. This percentage

is significantly reduced with the application of calcium hydroxide mixed with distilled water in the form of a paste, to the orifice of teeth that have undergone internal whitening treatment. Although, it is worth noting that the thermocatalytic technique is a procedure that is no longer recommended, in terms of the evolution of internal bleaching techniques. Tooth color is an important element of aesthetics. The smile is aesthetically beautiful when, in addition to the teeth, we smile, exposing the gingiva, which should be pink in color. The papillary gingiva should cover the interdental spaces below the point of contact. From the aesthetic point of view of the smile, an important element is also the color of the teeth, which becomes the main element, when priority is given at high levels by the patient himself. The improvement of the image contributes to the increase of self-esteem accompanied by positive psychological effects [1], [4], [12], [35].

During the publication years 2020-2022, there are about 11 articles published about dental whitening, which make up about 38% of the weight of articles in total. In this period of years, scientific research has been oriented around animal experiments and obtaining results from the *in vitro* assessment of bleaching side effects, if this period of years is compared with the time period 2016-2019, which also includes the majority of collected articles about 41%, these articles had the main focus of studying the results of *in vitro* interventions in humans and review type studies. In the period of 2021-2015, scientific research about dental whitening was rather "spartan" by conducting *in vivo* and *in vitro* studies in humans. In other words, the trend for finding data about the side effects of bleaching has been linear regardless of the years of publication.

In 45% of the articles, it is emphasized that the action of the teeth whitening solution is based on the chemical processes of interaction, in 24% of the articles this process is thought to be based on the physical basis of its realization and in 31% of the articles the mode of action of the whitening solution on the surface of the tooth is thought to be of physicochemical character. According to *in vitro* studies, 21% support the chemical effect of the bleaching solution, 2% support the physical effect of the action of the bleaching solution and 17% support the physical-chemical action of the bleaching solution on the surface of the tooth. According to *in vivo* studies: 17% of the articles support the chemical action of the bleaching solution, 7% the physical effect of the action and 10% support the physical-chemical effect of the action of the bleaching solution on the surface of the tooth where it is applied. Review-type studies analyze this interaction process only with a chemical or physical character and do not see it as a physicochemical process, while questionnaire studies look at this type of action based on both types of processes, i.e., with physicochemical character.

Based on the data in Table III, the appearance of side effects of dental whitening, unwanted and harmful effects sometimes reaches up to 61% support in the articles included in the study, where the highest value is the appearance of surface abrasiveness enamel with 31%, the appearance of pulpal inflammation in the value of 10%. If these values are added to the percentage values of the combination of pulpal

inflammation and abrasiveness at the same time and sensitivity and abrasiveness at the same time, the final values of abrasiveness of 34% and sensitivity of 10% are reached.

From the data in Table IV, it appears that bleaching appears as a truly mini-invasive procedure, but the damage it causes to the tooth structure goes up to 62%, based on the highest value of 34% according to *in vitro* experimental studies and on the value of 21% in *in vivo* type studies. The data in Table V show that most of the studies on dental bleaching were performed, about 59% of them in samples with less than 50 elements and only 31% in studies with samples with more than 51 elements. These samples can be patients, numbers of teeth or blocks of dental structures.

#### IV. CONCLUSIONS

The side effects of dental bleaching have been further evaluated through *in vitro* studies in humans, on blocks of dental structures from teeth scheduled for extraction. This analysis technique gives the advantage of obtaining results both *in vivo* and *in vitro* of the application of bleaching materials, also trying to apply high percentages of the solution to find the ceiling or the limit of what the most effective percentage of the solution should be to whiten with as few side effects as possible.

The whitening material, regardless of its type, acts on the dental structure according to predetermined physical, chemical processes or based on their combination of the physicochemical type. There is no higher dominant percentage than which process the bleaching solution acts on.

Sensitivity is the most mentioned side effect of dental whitening, for which sensitization is normal for both professionals and patients, but the less advertised side effect, but with a higher incidence, is the abrasiveness of the enamel surface. It should be attempted for studies with larger samples of patients, teeth of patients or animals with similar dental structures, to obtain the most significant results about the side effects of whitening solutions on teeth.

#### LIST OF ABBREVIATIONS

Not Applicable.

#### DECLARATIONS

##### *Ethics approval and consent to participate*

Not Applicable. This study does not require an ethical approval since individual patient data are not included in any form.

##### *Consent for Publication*

Not Applicable.

##### *Availability of Data and Materials*

The datasets analyzed during the current study are available from the corresponding author.

##### *Competing Interests*

The authors declare that they have no competing interests.

#### *Funding*

No funding was obtained for this study.

#### AUTHORS' CONTRIBUTIONS

IR collected the scientific data and wrote the manuscript. SH and NA revised and edited the manuscript. Literature research was conducted by IR and ED. SH and VO collected the scientific data. All authors read and approved the final manuscript.

#### ACKNOWLEDGMENTS

Acknowledgments belong to Henri and Hera, for the help they give us by understanding and supporting us to continue further and with more commitment, in the field of scientific research.

#### REFERENCES

- [1] Teughels W, Quirynen M, Jakubowicz N. Periodontal microbiology. In: Newman MG, Takei HH, Klokkevold PR, Carranza FA, editors. Carranza's Clinical Periodontology. 11<sup>th</sup> ed. St. Louis, Missouri: Saunders Publication; 2012.
- [2] Lima SNL, Ribeiro IS, Grisotto MA, Fernandes ES, Hass V, de Jesus Tavares RR, Pinto SCS, Lima DM, Loguercio AD, Bandeca MC.; "Evaluation of several clinical parameters after bleaching with hydrogen peroxide at different concentrations: A randomized clinical trial."; J Dent. 2018 Jan;68:91-97. doi: 10.1016/j.jdent.2017.11.008. Epub 2017 Nov 21.
- [3] Krasniqi TP, Lila-Krasniqi Z, Ajeti N, Shala K, Bicaj T, Dula L.; "Differences of Tooth Colorimetric Parameters L\*a\*b\* Depended on Age."; Open Access Maced J Med Sci. 2017 Oct 7;5(6):777-780. doi: 10.3889/oamjms.2017.155. eCollection 2017 Oct 15.
- [4] Shaista Afroz, Shradha Rath, Geeta Rajput, Sajjad Abdur Rahman; "Dental Esthetics and Its Impact on Psycho-Social Well-Being and Dental Self Confidence: A Campus Based Survey of North Indian University Students"; J Indian Prosthodont Soc. 2013 Dec; 13(4): 455-460. doi: 10.1007/s13191-012-0247-1.
- [5] Jha N, Ryu JJ, Choi EH, Kaushik NK.; "Generation and Role of Reactive Oxygen and Nitrogen Species Induced by Plasma, Lasers, Chemical Agents, and Other Systems in Dentistry."; Oxid Med Cell Longev. 2017;2017:7542540. doi: 10.1155/2017/7542540. Epub 2017 Oct 24.
- [6] Duangthip D, Fung MHT, Wong MCM, Chu CH, Lo ECM.; "Adverse Effects of Silver Diamine Fluoride Treatment among Preschool Children."; J Dent Res. 2018 Apr;97(4):395-401. doi: 10.1177/0022034517746678. Epub 2017 Dec 13.
- [7] Gul P, Harorli OT, Ocal IB, Ergin Z, Barutcgil C.; "Color recovery effect of different bleaching systems on a discolored composite resin."; Niger J Clin Pract. 2017 Oct;20(10):1226-1232. doi: 10.4103/njcp.njcp\_385\_16.
- [8] Westland S, Luo W, Li Y, Pan Q, Joiner A.; "Investigation of the perceptual thresholds of tooth whiteness."; J Dent. 2017 Dec;67S:S11-S14. doi: 10.1016/j.jdent.2017.09.013.
- [9] McMorrow SM, Millett DT.; "Adult orthodontics in the Republic of Ireland: specialist orthodontists' opinions."; J Orthod. 2017 Dec;44(4):277-286. doi: 10.1080/14653125.2017.1403144. Epub 2017 Nov 24.
- [10] Alencar CM, Pedrinha VF, Araújo JLN, Esteves RA, Silva da Silveira AD, Silva CM.; "Effect of 10% Strontium Chloride and 5% Potassium Nitrate with Fluoride on Bleached Bovine Enamel."; Open Dent J. 2017 Aug 31;11:476-484. doi: 10.2174/1874210601711010476. eCollection 2017.
- [11] Guo YR, Yang X, Feng XW, Sa Y, Wang M, Li P, Jiang T.; "New Insights into Effects of Aromatic Amino Acids on Hydroxyapatite."; J Dent Res. 2018 Apr;97(4):402-408. doi: 10.1177/0022034517741274. Epub 2017 Nov 12.
- [12] Manisha Behl, Arun K Patnana, Vikram Khanna, Kirti Chaudhry; "Evaluation of Three Different Bleaching Agents in Permanent and Primary Teeth: An In Vitro Study"; Int J Clin Pediatr Dent. Mar-Apr 2020;13(2):130-135. doi: 10.5005/jp-journals-10005-1721.
- [13] Gomes YSL, Alexandrino LD, Alencar CM, Alves EB, Faial KC, Silva CM.; "In situ Effect of Nanohydroxyapatite Paste in Enamel Teeth

- Bleaching.”; *J Contemp Dent Pract.* 2017 Nov 1;18(11):996-1003.
- [14] Asnaashari M, Ashraf H, Daghayeghi AH, Mojahedi SM, Azari-Marhabi S.; “Management of Post Endodontic Retreatment Pain with Low Level Laser Therapy.”; *J Lasers Med Sci.* 2017 Summer;8(3):128-131. doi: 10.15171/jlms.2017.23. Epub 2017 Jun 27.
- [15] de Baat C, Zweers PGMA, van Loveren C, Vissink A.; “Medicaments and oral healthcare 5. Adverse effects of -medications and over-the-counter drugs on teeth.”; *Ned Tijdschr Tandheelkd.* 2017 Oct;124(10):485-491. doi: 10.5177/ntvt.2017.10.17142.
- [16] Wongpraparatana I, Matangkasombut O, Thanyasrisung P, Panich M.; “Effect of Vital Tooth Bleaching on Surface Roughness and Streptococcal Biofilm Formation on Direct Tooth-Colored Restorative Materials.”; *Oper Dent.* 2018 Jan/Feb;43(1):51-59. doi: 10.2341/16-366-L. Epub 2017 Oct 4.
- [17] Priscila Christiane Suzy Liporoni, Wan Zaripah Wan Bakar, Rayssa Ferreira Zanatta, Glauca Maria Ambrosano, Flávio Henrique Baggio Aguiar, Bennett T Amaechil; “Influence of Erosion/Abrasion and the Dentifrice Abrasiveness Concomitant with Bleaching Procedures”; *Clin Cosmet Investig Dent*; 2020 Apr 1;12:101-109. doi: 10.2147/CCIDE.S234716. eCollection 2020.
- [18] de Geus JL, Wambier LM, Boing TF, Loguercio AD, Reis A.; “At-home Bleaching With 10% vs More Concentrated Carbamide Peroxide Gels: A Systematic Review and Meta-analysis.”; *Oper Dent.* 2018 Jul/Aug;43(4):E210-E222. doi: 10.2341/17-222-L.
- [19] Vargas-Koudriavtsev T, Durán-Sedó R, Herrera-Sancho ÓA; “Titanium dioxide in dental enamel as a trace element and its variation with bleaching”; *J Clin Exp Dent.* 2018 Jun 1;10(6):e537-e541. doi: 10.4317/jced.54478. eCollection 2018 Jun.
- [20] Rodrigues JL, Rocha PS, Pardim SLS, Machado ACV, Faria-E-Silva AL, Seraidarian PI; “Association Between In-Office and At-Home Tooth Bleaching: A Single Blind Randomized Clinical Trial.”; *Braz Dent J.* 2018 Mar-Apr;29(2):133-139. doi: 10.1590/0103-6440201801726.
- [21] Ergin E, RuyaYazici A, Kalender B, Usumez A, Ertan A, Gorucu J, Sari T.; “In vitro comparison of an Er:YAG laser-activated bleaching system with different light-activated bleaching systems for color change, surface roughness, and enamel bond strength.”; *Lasers Med Sci.* 2018 Jun 2. doi: 10.1007/s10103-018-2555-0. Epub ahead of print.
- [22] Chemin K, Rezende M, Loguercio AD, Reis A, Kossatz S.; “Effectiveness of and Dental Sensitivity to At-home Bleaching With 4% and 10% Hydrogen Peroxide: A Randomized, Triple-blind Clinical Trial.”; *Oper Dent.* 2018 May/Jun;43(3):232-240. doi: 10.2341/16-260-C.
- [23] Coppla FM, Rezende M, de Paula E, Farago PV, Loguercio AD, Kossatz S, Reis A.; “Combination of Acetaminophen/Codeine Analgesics Does Not Avoid Bleaching-Induced Tooth Sensitivity: A Randomized, Triple-Blind Two-Center Clinical Trial.”; *Oper Dent.* 2018 Mar/Apr;43(2):E53-E63. doi: 10.2341/17-092-C.
- [24] López Darriba I, Novoa L, de la Peña VA.; “Efficacy of different protocols for at-home bleaching: A randomized clinical trial.”; *Am J Dent.* 2017 Dec;30(6):329-334.
- [25] Shahabi S, Assadian H, Mahmoudi Nahavandi A, Nokhbatolfighahaci H.; “Comparison of Tooth Color Change After Bleaching with Conventional and Different Light-Activated Methods.”; *J Lasers Med Sci.* 2018 Winter;9(1):27-31. doi: 10.15171/jlms.2018.07. Epub 2017 Dec 26.
- [26] Rahul M, Kumar PA, Nair AS, Mathew S, Amaladas AS, Ommen A.; “Effects of at-home and in-office bleaching agents on the shear bond strength of metal, ceramic, and composite brackets to enamel.”; *Indian J Dent Res.* 2017 Sep-Oct;28(5):566-573. doi: 10.4103/ijdr.IJDR\_13\_17.
- [27] Vahid Esfahanian, Mehrnaz Sadighi Shamami, Mehmooosh Sadighi Shamami; “Relationship between osteoporosis and periodontal disease: Review of the literature”; *J Dent (Terhan)*; 2012 Autumn: 9(4): 256-264.
- [28] Iska D, Devanna R, Singh M, Chitumalla R, Balasubramanian SCB, Goutam M; “In vitro Assessment of Influence of Various Bleaching Protocols on the Strength of Ceramic Orthodontic Brackets bonded to Bleached Tooth Surface: A Comparative Study”; *J Contemp Dent Pract.* 2017 Dec 1;18(12):1181-1184.
- [29] Nie J, Tian FC, Wang ZH, Yap AU, Wang XY.; “Comparison of efficacy and outcome satisfaction between in-office and home teeth bleaching in Chinese patients.”; *J Oral Sci.* 2017 Dec 27;59(4):527-532. doi: 10.2334/josnud.16-0636. Epub 2017 Nov 17.
- [30] Kaewpinta A, Khongkhunthian S, Chaijareenont P, Okonogi S.; “Tooth whitening efficacy of pigmented rice gels containing carbamide peroxide.”; *Drug Discov Ther.* 2018;12(3):126-132. doi: 10.5582/ddt.2018.01023.
- [31] Bersezio C, Martin J, Angel P, Bottner J, Godoy I, Avalos F, Fernández E.; “Teeth whitening with 6% hydrogen peroxide and its impact on quality of life: 2 years of follow-up.”; 2018 Jun 30. doi: 10.1007/s10266-018-0372-3. Epub ahead of print.
- [32] AlSheikh R, El-Embaby AE; “Spectrophotometric Comparison of Effectiveness of Two In-office Bleaching Agents with/without Light Activation: A Clinical Study.”; *J Contemp Dent Pract.* 2018 Jun 1;19(6):637-641.
- [33] Angel P, Bersezio C, Estay J, Werner A, Retamal H, Araya C, Martin J, Fernández E.; “Color stability, psychosocial impact, and effect on self-perception of esthetics of toothwhitening using low-concentration (6%) hydrogen peroxide.”; *Quintessence Int.* 2018;49(7):557-566. doi: 10.3290/j.qi.a40468.
- [34] Nahsan FPS, Reis MJO, Francisconi-Dos-Rios LF, Leão LV, ParanhosLR.; “Effectiveness of whitening mouthwashes on tooth color: an in vitro study.”; *Gen Dent.* 2018 Mar-Apr;66(2):e7-e10.
- [35] Wang S, Cathro P, Heithersay G, Briggs N, Ratnayake J, Zilm P.; “A colourimetric evaluation of the effect of bacterial contamination on teeth stained with blood *in vitro*: Evaluation of the efficacy of two different bleaching regimes.”; *Aust Dent J.* 2018 Jun;63(2):253-260. doi: 10.1111/adj.12604. Epub 2018 Apr 16.
- [36] Vejai Vekaash CJ, Kumar Reddy TV, Venkatesh KV.; “Effect of vital bleaching with solutions containing different concentrations of hydrogen peroxide and pineapple extract as an additive on human enamel using reflectance spectrophotometer: An *in vitro* study.”; *J Conserv Dent.* 2017 Sep-Oct;20(5):337-340. doi: 10.4103/JCD.JCD\_197\_17.
- [37] Menezes RP, Silva PD, Leal PC, Faria-E-Silva AL.; “Impact of 35% Hydrogen Peroxide on Color and Translucency Changes in Enamel and Dentin.”; *Braz Dent J.* 2018 Jan-Feb;29(1):88-92. doi: 10.1590/0103-6440201801553.
- [38] Al-Omiri MK, Abul Hassan RS, AlZarea BK, Lynch E.; “Comparison of dental bleaching effects of ozone and hydrogen peroxide: An ex vivo study.”; *Am J Dent.* 2016 Oct;29(5):251-254.
- [39] Bizhang M, Domin J, Danesh G, Zimmer S.; “Effectiveness of a new non-hydrogen peroxide bleaching agent after single use - a double-blind placebo-controlled short-term study.”; *J Appl Oral Sci.* 2017 Sep-Oct;25(5):575-584. doi: 10.1590/1678-7757-2016-0463.
- [40] de Souza Rastelli AN, Dias HB, Carrera ET, de Barros ACP, Dos Santos DDL, Panhóca VH, Bagnato VS; “Violet LED associated to low concentration carbamide peroxide on the dental bleaching: A case report.”; *Photodiagnosis Photodyn Ther.* 2018 Jun 28. pii: S1572-1000(17)30499-4. doi: 10.1016/j.pdpdt.2018.06.021.
- [41] Vieira-Junior WF, Ferraz LN, Giorgi M, Ambrosano G, Aguiar F, Lima D.; “Effect of Mouth Rinse Treatments on Bleached Enamel Properties, Surface Morphology, and Tooth Color.”; *Oper Dent.* 2018 Jun 28. doi: 10.2341/17-250-L. Epub ahead of print.
- [42] [https://thewhytehouse.com/wp-content/uploads/2018/03/IMG\\_0293.jpg](https://thewhytehouse.com/wp-content/uploads/2018/03/IMG_0293.jpg)
- [43] Umar, Ibrahim Abdullahi and Hakan Kamalak. “Bleaching Discolored Devalte Teeth with Using of New Agents.” *IOSR Journal of Dental and Medical Sciences* 13 (2014): 79-82.
- [44] <https://www.dentvitalis.com/images/izbjeljivanje-zuba.jpg>
- [45] [https://media.springernature.com/lw685/springerstatic/image/art%3A10.1007%2Fs41894-018-00219/MediaObjects/41894\\_2018\\_21\\_Fig5\\_HTML.jpg](https://media.springernature.com/lw685/springerstatic/image/art%3A10.1007%2Fs41894-018-00219/MediaObjects/41894_2018_21_Fig5_HTML.jpg)
- [46] <https://healthinfo.healthengine.com.au/home-bleaching-home-tooth-whitening>
- [47] [https://d3b3by4navwslf.cloudfront.net/shutterstock\\_119225470.jpg](https://d3b3by4navwslf.cloudfront.net/shutterstock_119225470.jpg)
- [48] Epple M, Meyer F, Enax J. A Critical Review of Modern Concepts for Teeth Whitening. *Dent J (Basel).* 2019 Aug 1;7(3):79. doi: 10.3390/dj7030079. PMID: 31374877; PMCID: PMC6784469.
- [49] Madeswaran S, Jayachandran S. Sodium bicarbonate: A review and its uses in dentistry. *Indian J Dent Res.* 2018 Sep-Oct;29(5):672-677. doi: 10.4103/ijdr.IJDR\_30\_17. PMID: 30409952.
- [50] Eachempati P, Kumbargere Nagraj S, Kiran Kumar Krishanappa S, Gupta P, Yaylali IE. Home-based chemically-induced whitening (bleaching) of teeth in adults. *Cochrane Database Syst Rev.* 2018 Dec 18;12(12):CD006202. doi: 10.1002/14651858.CD006202.pub2. PMID: 30562408; PMCID: PMC6517292.
- [51] Lilaj B, Dauti R, Agis H, Schmid-Schwab M, Franz A, Kanz F, Moritz A, Schedle A, Cvikl B. Comparison of Bleaching Products with up to 6% and with More Than 6% Hydrogen Peroxide: Whitening Efficacy Using BI and WI<sub>D</sub> and Side Effects - An *in vitro* Study. *Front Physiol.* 2019 Aug 21;10:919. doi: 10.3389/fphys.2019.00919. PMID: 31543822; PMCID: PMC6728628.
- [52] De Moor RJ, Verheyen J, Verheyen P, Diachuk A, Meire MA, De Coster PJ, De Bruyne M, Keulemans F. Laser teeth bleaching: evaluation of eventual side effects on enamel and the pulp and the efficiency *in vitro*

- and in vivo. *ScientificWorldJournal*. 2015;2015:835405. doi: 10.1155/2015/835405. Epub 2015 Mar 22. PMID: 25874258; PMCID: PMC4385673.
- [53] Chen C, Huang X, Zhu W, Ding C, Huang P, Li R. TRPA1 triggers hyperalgesia and inflammation after tooth bleaching. *Sci Rep*. 2021 Aug 31;11(1):17418. doi: 10.1038/s41598-021-97040-w. PMID: 34465829; PMCID: PMC8408176.
- [54] Mazilu A, Popescu V, Sarosi C, Dumitrescu RS, Chisnoiu AM, Moldovan M, Dumitrescu LS, Prodan D, Carpa R, Gheorghe GF, Chisnoiu RM. Preparation and In Vitro Characterization of Gels Based on Bromelain, Whey and Quince Extract. *Gels*. 2021 Oct 30;7(4):191. doi: 10.3390/gels7040191. PMID: 34842665; PMCID: PMC8628677.
- [55] Fiorillo L, Laino L, De Stefano R, D'Amico C, Bocchieri S, Amoroso G, Isola G, Cervino G. Dental Whitening Gels: Strengths and Weaknesses of an Increasingly Used Method. *Gels*. 2019 Jul 4;5(3):35. doi: 10.3390/gels5030035. PMID: 31277412; PMCID: PMC6787621.
- [56] Furukawa M, Wang J, Kurosawa M, Ogiso N, Shikama Y, Kanekura T, Matsushita K. Effect of green propolis extracts on experimental aged gingival irritation in vivo and in vitro. *J Oral Biosci*. 2021 Mar;63(1):58-65. doi: 10.1016/j.job.2020.12.003. Epub 2021 Jan 21. PMID: 33484883.
- [57] De Miranda MSF, Eltom AE, Souza Camargo S, Rocha GM, Reis Perez CD. Effect of different home-bleaching techniques for a regular or an extended time on enamel properties. *Indian J Dent Res*. 2020 Nov-Dec;31(6):924-929. doi: 10.4103/ijdr.IJDR\_791\_19. PMID: 33753666.
- [58] Monteiro J, Ashley PF, Parekh S. Vital bleaching for children with dental anomalies: EAPD members' survey. *Eur Arch Paediatr Dent*. 2020 Oct;21(5):565-571. doi: 10.1007/s40368-019-00494-w. Epub 2019 Nov 29. PMID: 31784871; PMCID: PMC7518994.
- [59] Orilisi G, Tosco V, Monterubbianesi R, Notarstefano V, Özcan M, Putignano A, Orsini G. ATR-FTIR, EDS and SEM evaluations of enamel structure after treatment with hydrogen peroxide bleaching agents loaded with nano-hydroxyapatite particles. *PeerJ*. 2021 Jan 29;9:e10606. doi: 10.7717/peerj.10606. PMID: 33575125; PMCID: PMC7849511.
- [60] Chen C, Huang X, Zhu W, Ding C, Huang P, Li R. H2O2 gel bleaching induces cytotoxicity and pain conduction in dental pulp stem cells via intracellular reactive oxygen species on enamel/dentin disc. *PLoS One*. 2021 Sep 10;16(9):e0257221. doi: 10.1371/journal.pone.0257221. PMID: 34506603; PMCID: PMC8432789.
- [61] Gallinari MO, Cintra LTÁ, Benetti F, Rahal V, Ervolino E, Briso ALF. Pulp response of rats submitted to bleaching and the use of different anti-inflammatory drugs. *PLoS One*. 2019 Jan 8;14(1):e0210338. doi: 10.1371/journal.pone.0210338. PMID: 30620760; PMCID: PMC6324791.
- [62] Li Y, Shi X, Li W. Zinc-Containing Hydroxyapatite Enhances Cold-Light-Activated Tooth Bleaching Treatment In Vitro. *Biomed Res Int*. 2017;2017:6261248. doi: 10.1155/2017/6261248. Epub 2017 Oct 12. PMID: 29159178; PMCID: PMC5660759.
- [63] Roderjan DA, Stanislawczuk R, Hebling J, Costa CA, Reis A, Loguercio AD. Response of human pulps to different in-office bleaching techniques: preliminary findings. *Braz Dent J*. 2015 May-Jun;26(3):242-8. doi: 10.1590/0103-6440201302282. PMID: 26200147.
- [64] Akbari M, Nejat AH, Farkhondeh N, Mehraban Moghadam S, Hashemy SI, Mohammadipour HS. Does at-home bleaching induce systemic oxidative stress in healthy subjects? *Aust Dent J*. 2017 Mar;62(1):58-64. doi: 10.1111/adj.12425. Epub 2016 Dec 14. PMID: 27091347.
- [65] Omar F, Ab-Ghani Z, Rahman NA, Halim MS. Nonprescription Bleaching versus Home Bleaching with Professional Prescriptions: Which One is Safer? A Comprehensive Review of Color Changes and Their Side Effects on Human Enamel. *Eur J Dent*. 2019 Oct;13(4):589-598. doi: 10.1055/s-0039-1700659. Epub 2019 Dec 31. PMID: 31891975; PMCID: PMC6938424.
- [66] Diklić D, Sever EK, Galić N, Spajić J, Prskalo K. Attitudes of Students of Different Schools of University of Zagreb on Tooth Bleaching. *Acta Stomatol Croat*. 2016 Dec;50(4):301-309. doi: 10.15644/asc50/4/3. PMID: 28275277; PMCID: PMC5328645.
- [67] Alaghehmand H, Esmaeili B, Sheibani SA. Effect of fluoride-free and fluoridated carbamide peroxide gels on the hardness and surface roughness of aesthetic restorative materials. *Indian J Dent Res*. 2013 Jul-Aug;24(4):478-83. doi: 10.4103/0970-9290.118397. PMID: 24047842.
- [68] Celik EU, Yazkan B, Yildiz G, Tunac AT. Clinical performance of a combined approach for the esthetic management of fluorosed teeth: Three-year results. *Niger J Clin Pract*. 2017 Aug;20(8):943-951. doi: 10.4103/1119-3077.180066. PMID: 28891537.
- [69] Asnaashari M, Ashraf H, Daghayeghi AH, Mojahedi SM, Azari-Marhabi S. Management of Post Endodontic Retreatment Pain With Low Level Laser Therapy. *J Lasers Med Sci*. 2017 Summer;8(3):128-131. doi: 10.15171/jlms.2017.23. Epub 2017 Jun 27. PMID: 29123632; PMCID: PMC5662501.
- [70] Altshuler G, Belikov A, Skrypnik A, Feldchtein F, Pushkareva A, Shatilova K, Cernavin I, Tuchin V. Peroxide dental bleaching via laser microchannels and tooth color measurements. *J Biomed Opt*. 2016 Dec 1;21(12):125001. doi: 10.1117/1.JBO.21.12.125001. PMID: 27926747.
- [71] Mazilu Moldovan A, Popescu V, Ionescu CV, Cuc S, Craciun A, Moldovan M, Ducea D, Mesaros AS. Various Aspects Involved in the Study of Tooth Bleaching Procedure: A Questionnaire-Based Study. *Int J Environ Res Public Health*. 2022 Mar 27;19(7):3977. doi: 10.3390/ijerph19073977. PMID: 35409660; PMCID: PMC8997818.
- [72] Oldoini G, Bruno A, Genovesi AM, Parisi L. Effects of Amorphous Calcium Phosphate Administration on Dental Sensitivity during In-Office and At-Home Interventions. *Dent J (Basel)*. 2018 Oct 1;6(4):52. doi: 10.3390/dj6040052. PMID: 30275415; PMCID: PMC6313672.
- [73] Llana C, Collado-González M, García-Bernal D, Oñate-Sánchez RE, Martínez CM, Moraleda JM, Rodríguez-Lozano FJ, Forner L. Comparison of diffusion, cytotoxicity and tissue inflammatory reactions of four commercial bleaching products against human dental pulp stem cells. *Sci Rep*. 2019 May 23;9(1):7743. doi: 10.1038/s41598-019-44223-1. PMID: 31123303; PMCID: PMC6533274.
- [74] Babot-Marquillas C, Sánchez-Martín MJ, Amigo JM, Yousef I, H Valido I, Boada R, Valiente M. Tooth whitening effects on dental enamel, oxidation or reduction? Comparison of physicochemical alterations in bovine enamel using Synchrotron-based Micro-FTIR. *Dent Mater*. 2022 Apr;38(4):670-679. doi: 10.1016/j.dental.2022.02.006. Epub 2022 Mar 5. PMID: 35256209.
- [75] Soares DG, Sacono NT, Ribeiro APD, Leite ML, Duque CCO, Gallinari MO, Pacheco LE, Hebling J, Costa CAS. Pro-inflammatory mediators expression by pulp cells following tooth whitening on restored enamel surface. *Braz Dent J*. 2022 Mar-Apr;33(2):83-90. doi: 10.1590/0103-6440202204688. PMID: 35508040.
- [76] Abdelkader NN. Modified Technique for Nonvital Tooth Bleaching: A Case Report. *Electron Physician*. 2015 Oct 19;7(6):1423-6. doi: 10.14661/1423. PMID: 26516453; PMCID: PMC4623806.
- [77] Calderini A, Sciarra S, Semeria C, Pantaleo G, Polizzi E. Comparative clinical and psychosocial benefits of tooth bleaching: different light activation of a 38% peroxide gel in a preliminary case-control study. *Clin Case Rep*. 2016 Jun 21;4(8):728-35. doi: 10.1002/ccr3.605. PMID: 27525071; PMCID: PMC4974415.