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ЕЖЕМЕСЯЧНЫЙ НАУЧНЫЙ ЖУРНАЛ

Медицинские новости Грузии

საქართველოს სამედიცინო სიახლენი

GEORGIAN MEDICAL NEWS

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GMN: Georgian Medical News is peer-reviewed, published monthly journal committed to promoting the science and art of medicine and the betterment of public health, published by the GMN Editorial Board since 1994. GMN carries original scientific articles on medicine, biology and pharmacy, which are of experimental, theoretical and practical character; publishes original research, reviews, commentaries, editorials, essays, medical news, and correspondence in English and Russian.

GMN is indexed in MEDLINE, SCOPUS, PubMed and VINITI Russian Academy of Sciences. The full text content is available through EBSCO databases.

GMN: Медицинские новости Грузии - ежемесячный рецензируемый научный журнал, издаётся Редакционной коллегией с 1994 года на русском и английском языках в целях поддержки медицинской науки и улучшения здравоохранения. В журнале публикуются оригинальные научные статьи в области медицины, биологии и фармации, статьи обзорного характера, научные сообщения, новости медицины и здравоохранения. Журнал индексируется в MEDLINE, отражён в базе данных SCOPUS, PubMed и ВИНИТИ РАН. Полнотекстовые статьи журнала доступны через БД EBSCO.

GMN: Georgian Medical News – საქართველოს სამედიცინო სიახლენი – არის ყოველთვიური სამეცნიერო სამედიცინო რეცენზირებადი ჟურნალი, გამოიცემა 1994 წლიდან, წარმოადგენს სარედაქციო კოლეგიისა და აშშ-ის მეცნიერების, განათლების, ინდუსტრიის, ხელოვნებისა და ბუნებისმეტყველების საერთაშორისო აკადემიის ერთობლივ გამოცემას. GMN-ში რუსულ და ინგლისურ ენებზე ქვეყნდება ექსპერიმენტული, თეორიული და პრაქტიკული ხასიათის ორიგინალური სამეცნიერო სტატიები მედიცინის, ბიოლოგიისა და ფარმაციის სფეროში, მიმოხილვითი ხასიათის სტატიები.

ჟურნალი ინდექსირებულია MEDLINE-ის საერთაშორისო სისტემაში, ასახულია SCOPUS-ის, PubMed-ის და ВИНИТИ РАН-ის მონაცემთა ბაზებში. სტატიების სრული ტექსტი ხელმისაწვდომია EBSCO-ს მონაცემთა ბაზებიდან.

WEBSITE

www.geomednews.com

К СВЕДЕНИЮ АВТОРОВ!

При направлении статьи в редакцию необходимо соблюдать следующие правила:

1. Статья должна быть представлена в двух экземплярах, на русском или английском языках, напечатанная через **полтора интервала на одной стороне стандартного листа с шириной левого поля в три сантиметра**. Используемый компьютерный шрифт для текста на русском и английском языках - **Times New Roman** (**Кириллица**), для текста на грузинском языке следует использовать **AcadNusx.** Размер шрифта - **12**. К рукописи, напечатанной на компьютере, должен быть приложен CD со статьей.

2. Размер статьи должен быть не менее десяти и не более двадцати страниц машинописи, включая указатель литературы и резюме на английском, русском и грузинском языках.

3. В статье должны быть освещены актуальность данного материала, методы и результаты исследования и их обсуждение.

При представлении в печать научных экспериментальных работ авторы должны указывать вид и количество экспериментальных животных, применявшиеся методы обезболивания и усыпления (в ходе острых опытов).

4. К статье должны быть приложены краткое (на полстраницы) резюме на английском, русском и грузинском языках (включающее следующие разделы: цель исследования, материал и методы, результаты и заключение) и список ключевых слов (key words).

5. Таблицы необходимо представлять в печатной форме. Фотокопии не принимаются. **Все цифровые, итоговые и процентные данные в таблицах должны соответствовать таковым в тексте статьи**. Таблицы и графики должны быть озаглавлены.

6. Фотографии должны быть контрастными, фотокопии с рентгенограмм - в позитивном изображении. Рисунки, чертежи и диаграммы следует озаглавить, пронумеровать и вставить в соответствующее место текста **в tiff формате**.

В подписях к микрофотографиям следует указывать степень увеличения через окуляр или объектив и метод окраски или импрегнации срезов.

7. Фамилии отечественных авторов приводятся в оригинальной транскрипции.

8. При оформлении и направлении статей в журнал МНГ просим авторов соблюдать правила, изложенные в «Единых требованиях к рукописям, представляемым в биомедицинские журналы», принятых Международным комитетом редакторов медицинских журналов - http://www.spinesurgery.ru/files/publish.pdf и http://www.nlm.nih.gov/bsd/uniform_requirements.html
В конце каждой оригинальной статьи приводится библиографический список. В список литературы включаются все материалы, на которые имеются ссылки в тексте. Список составляется в алфавитном порядке и нумеруется. Литературный источник приводится на языке оригинала. В списке литературы сначала приводятся работы, написанные знаками грузинского алфавита, затем кириллицей и латиницей. Ссылки на цитируемые работы в тексте статьи даются в квадратных скобках в виде номера, соответствующего номеру данной работы в списке литературы. Большинство цитированных источников должны быть за последние 5-7 лет.

9. Для получения права на публикацию статья должна иметь от руководителя работы или учреждения визу и сопроводительное отношение, написанные или напечатанные на бланке и заверенные подписью и печатью.

10. В конце статьи должны быть подписи всех авторов, полностью приведены их фамилии, имена и отчества, указаны служебный и домашний номера телефонов и адреса или иные координаты. Количество авторов (соавторов) не должно превышать пяти человек.

11. Редакция оставляет за собой право сокращать и исправлять статьи. Корректура авторам не высылается, вся работа и сверка проводится по авторскому оригиналу.

12. Недопустимо направление в редакцию работ, представленных к печати в иных издательствах или опубликованных в других изданиях.

При нарушении указанных правил статьи не рассматриваются.

REQUIREMENTS

Please note, materials submitted to the Editorial Office Staff are supposed to meet the following requirements:

1. Articles must be provided with a double copy, in English or Russian languages and typed or compu-ter-printed on a single side of standard typing paper, with the left margin of **3** centimeters width, and **1.5** spacing between the lines, typeface - **Times New Roman** (**Cyrillic**), print size - **12** (referring to Georgian and Russian materials). With computer-printed texts please enclose a CD carrying the same file titled with Latin symbols.

2. Size of the article, including index and resume in English, Russian and Georgian languages must be at least 10 pages and not exceed the limit of 20 pages of typed or computer-printed text.

3. Submitted material must include a coverage of a topical subject, research methods, results, and review.

Authors of the scientific-research works must indicate the number of experimental biological species drawn in, list the employed methods of anesthetization and soporific means used during acute tests.

4. Articles must have a short (half page) abstract in English, Russian and Georgian (including the following sections: aim of study, material and methods, results and conclusions) and a list of key words.

5. Tables must be presented in an original typed or computer-printed form, instead of a photocopied version. **Numbers, totals, percentile data on the tables must coincide with those in the texts of the articles.** Tables and graphs must be headed.

6. Photographs are required to be contrasted and must be submitted with doubles. Please number each photograph with a pencil on its back, indicate author's name, title of the article (short version), and mark out its top and bottom parts. Drawings must be accurate, drafts and diagrams drawn in Indian ink (or black ink). Photocopies of the X-ray photographs must be presented in a positive image in **tiff format**.

Accurately numbered subtitles for each illustration must be listed on a separate sheet of paper. In the subtitles for the microphotographs please indicate the ocular and objective lens magnification power, method of coloring or impregnation of the microscopic sections (preparations).

7. Please indicate last names, first and middle initials of the native authors, present names and initials of the foreign authors in the transcription of the original language, enclose in parenthesis corresponding number under which the author is listed in the reference materials.

8. Please follow guidance offered to authors by The International Committee of Medical Journal Editors guidance in its Uniform Requirements for Manuscripts Submitted to Biomedical Journals publication available online at: http://www.nlm.nih.gov/bsd/uniform_requirements.html
http://www.icmje.org/urm_full.pdf
In GMN style for each work cited in the text, a bibliographic reference is given, and this is located at the end of the article under the title "References". All references cited in the text must be listed. The list of references should be arranged alphabetically and then numbered. References are numbered in the text [numbers in square brackets] and in the reference list and numbers are repeated throughout the text as needed. The bibliographic description is given in the language of publication (citations in Georgian script are followed by Cyrillic and Latin).

9. To obtain the rights of publication articles must be accompanied by a visa from the project instructor or the establishment, where the work has been performed, and a reference letter, both written or typed on a special signed form, certified by a stamp or a seal.

10. Articles must be signed by all of the authors at the end, and they must be provided with a list of full names, office and home phone numbers and addresses or other non-office locations where the authors could be reached. The number of the authors (co-authors) must not exceed the limit of 5 people.

11. Editorial Staff reserves the rights to cut down in size and correct the articles. Proof-sheets are not sent out to the authors. The entire editorial and collation work is performed according to the author's original text.

12. Sending in the works that have already been assigned to the press by other Editorial Staffs or have been printed by other publishers is not permissible.

Articles that Fail to Meet the Aforementioned Requirements are not Assigned to be Reviewed.

ავტორთა საყურადღებოდ!

რედაქციაში სტატიის წარმოდგენისას საჭიროა დავიცვათ შემდეგი წესები:

1. სტატია უნდა წარმოადგინოთ 2 ცალად, რუსულ ან ინგლისურ ენებზე,დაბეჭდილი სტანდარტული ფურცლის 1 გვერდზე, 3 სმ სიგანის მარცხენა ველისა და სტრიქონებს შორის 1,5 ინტერვალის დაცვით. გამოყენებული კომპიუტერული შრიფტი რუსულ და ინგლისურენოვან ტექსტებში - **Times New Roman (Кириллица)**, ხოლო ქართულენოვან ტექსტში საჭიროა გამოვიყენოთ **AcadNusx.** შრიფტის ზომა – 12. სტატიას თან უნდა ახლდეს CD სტატიით.

2. სტატიის მოცულობა არ უნდა შეადგენდეს 10 გვერდზე ნაკლებს და 20 გვერდზე მეტს ლიტერატურის სიის და რეზიუმეების (ინგლისურ, რუსულ და ქართულ ენებზე) ჩათვლით.

3. სტატიაში საჭიროა გაშუქდეს: საკითხის აქტუალობა; კვლევის მიზანი; საკვლევი მასალა და გამოყენებული მეთოდები; მიღებული შედეგები და მათი განსჯა. ექსპერიმენტული ხასიათის სტატიების წარმოდგენისას ავტორებმა უნდა მიუთითონ საექსპერიმენტო ცხოველების სახეობა და რაოდენობა; გაუტკივარებისა და დაძინების მეთოდები (მწვავე ცდების პირობებში).

4. სტატიას თან უნდა ახლდეს რეზიუმე ინგლისურ, რუსულ და ქართულ ენებზე არანაკლებ ნახევარი გვერდის მოცულობისა (სათაურის, ავტორების, დაწესებულების მითითებით და უნდა შეიცავდეს შემდეგ განყოფილებებს: მიზანი, მასალა და მეთოდები, შედეგები და დასკვნები; ტექსტუალური ნაწილი არ უნდა იყოს 15 სტრიქონზე ნაკლები) და საკვანძო სიტყვების ჩამონათვალი (key words).

5. ცხრილები საჭიროა წარმოადგინოთ ნაბეჭდი სახით. ყველა ციფრული, შემაჯამებელი და პროცენტული მონაცემები უნდა შეესაბამებოდეს ტექსტში მოყვანილს.

6. ფოტოსურათები უნდა იყოს კონტრასტული; სურათები, ნახაზები, დიაგრამები - დასათაურებული, დანომრილი და სათანადო ადგილას ჩასმული. რენტგენოგრამების ფოტოასლები წარმოადგინეთ პოზიტიური გამოსახულებით **tiff** ფორმატში. მიკროფოტოსურათების წარწერებში საჭიროა მიუთითოთ ოკულარის ან ობიექტივის საშუალებით გადიდების ხარისხი, ანათალების შეღებვის ან იმპრეგნაციის მეთოდი და აღნიშნოთ სურათის ზედა და ქვედა ნაწილები.

7. სამამულო ავტორების გვარები სტატიაში აღინიშნება ინიციალების თანდართვით, უცხოურისა – უცხოური ტრანსკრიპციით.

8. სტატიას თან უნდა ახლდეს ავტორის მიერ გამოყენებული სამამულო და უცხოური შრომების ბიბლიოგრაფიული სია (ბოლო 5-8 წლის სიღრმით). ანბანური წყობით წარმოდგენილ ბიბლიოგრაფიულ სიაში მიუთითეთ ჯერ სამამულო, შემდეგ უცხოელი ავტორები (გვარი, ინიციალები, სტატიის სათაური, ჟურნალის დასახელება, გამოცემის ადგილი, წელი, ჟურნალის №, პირველი და ბოლო გვერდები). მონოგრაფიის შემთხვევაში მიუთითეთ გამოცემის წელი, ადგილი და გვერდების საერთო რაოდენობა. ტექსტში კვადრატულ ფჩხილებში უნდა მიუთითოთ ავტორის შესაბამისი N ლიტერატურის სიის მიხედვით. მიზანშეწონილია, რომ ციტირებული წყაროების უმეტესი ნაწილი იყოს 5-6 წლის სიღრმის.

9. სტატიას თან უნდა ახლდეს: ა) დაწესებულების ან სამეცნიერო ხელმძღვანელის წარდგინება, დამოწმებული ხელმოწერითა და ბეჭდით; ბ) დარგის სპეციალისტის დამოწმებული რეცენზია, რომელშიც მითითებული იქნება საკითხის აქტუალობა, მასალის საკმაობა, მეთოდის სანდოობა, შედეგების სამეცნიერო-პრაქტიკული მნიშვნელობა.

10. სტატიის ბოლოს საჭიროა ყველა ავტორის ხელმოწერა, რომელთა რაოდენობა არ უნდა აღემატებოდეს 5-ს.

11. რედაქცია იტოვებს უფლებას შეასწოროს სტატია. ტექსტზე მუშაობა და შეჯერება ხდება საავტორო ორიგინალის მიხედვით.

12. დაუშვებელია რედაქციაში ისეთი სტატიის წარდგენა, რომელიც დასაბეჭდად წარდგენილი იყო სხვა რედაქციაში ან გამოქვეყნებული იყო სხვა გამოცემებში.

აღნიშნული წესების დარღვევის შემთხვევაში სტატიები არ განიხილება.

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IMPACT OF PHOTODYNAMIC THERAPY ON ORAL HEALTH IN PATIENTS UNDERGOING FIXED ORTHODONTIC TREATMENT: A RANDOMIZED CONTROLLED TRIAL

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Abstract.

Aim: This study aimed to evaluate the effects of photodynamic laser therapy (PDT) on the condition of gingiva and dental plaque in patients with fixed orthodontic appliances (FOA) at various time intervals during orthodontic treatment.

Methodology: This research is a randomized controlled trial involving 60 patients with fixed orthodontic appliances, divided into two groups of 30 each. The first group served as the control, while the second group received the photodynamic treatment. Assessments of gingival and plaque conditions were conducted at two different time intervals. On the first day (T1), the gingival condition and dental plaque levels were evaluated using the gingival index (GI) and the dental plaque index (DPI) based on the Löe-Sillness and Sillness-Löe indexes. The test group was administered PDT with methylene blue, while the control group did not receive laser activation. On the 30th day (T2), gingival and plaque conditions were re-evaluated using the GI and DPI. Results were analyzed with SPSS, using independent samples t-tests and repeated measures ANOVA.

Results: In T1, the gingival condition according to GI in the test group was 50% mild inflammation, 36.7% normal, and 13.3% moderate inflammation. In T2, it shifted to 50% normal, 43.3% mild, and 6.7% moderate inflammation. Dental plaque at T1 according to DPI: 40% had film on the gingival margin, 36.7% moderate deposits in pocket, 16.7% no plaque, and 6.7% abundant soft matter. At T2: 56.7% film on margin, 30% no plaque, 13.3% moderate deposits in pocket. ANOVA revealed significant differences in GI and DPI ($p < 0.05$).

Conclusions: PDT with methylene blue demonstrates a statistically significant improvement in gingival health and reduction in dental plaque accumulation in patients undergoing FOA. This suggests that PDT could be a valuable adjunct to traditional oral hygiene practices for managing gingivitis and plaque-related issues in orthodontic patients.

Key words. Photodynamic therapy, gingival index, dental plaque index, fixed orthodontic appliances.

Introduction.

As awareness of facial aesthetics continues to rise, there has been a marked increase in patients pursuing orthodontic treatment. Various orthodontic devices, ranging from clear aligners to braces, are available [1]. However, due to recent concerns regarding the potential drawbacks of clear aligners [2-4], fixed orthodontic appliances (FOA) are often regarded as the preferred option for many patients [5].

FOA are extensively utilized to correct malocclusions and enhance both dental aesthetics and functionality [6,7]. However, research indicates that the presence of dental appliances, particularly orthodontic devices, in the oral cavity over time significantly alters the oral microflora, leading to an increased prevalence of periodontal pathogens that can have both systemic and local effects on patients [8-11]. Additionally, FOA can hinder routine oral hygiene, resulting in greater accumulation of dental plaque and an elevated risk of gingival inflammation and periodontal disease. The brackets, wires, and other components of these appliances create additional surfaces and niches conducive to bacterial colonization, complicating effective plaque control for both patients and clinicians [12,13].

Gingivitis, characterized by inflammation of the gingival tissues, is a common complication encountered during orthodontic treatment. If not adequately managed, it may progress to periodontitis, thereby jeopardizing both periodontal health and orthodontic outcomes [14]. Conventional mechanical plaque control methods, such as tooth brushing and interdental cleaning, frequently prove insufficient for patients with fixed appliances, highlighting the need for adjunctive therapies to enhance oral hygiene and prevent periodontal complications [15].

Photodynamic therapy (PDT) has emerged as a promising adjunctive treatment for managing various oral diseases, including periodontal and peri-implant infections. PDT involves the application of a photosensitizing agent, such as methylene blue, followed by activation with a specific wavelength of light. This process generates reactive oxygen species that selectively eliminate pathogenic microorganisms while preserving surrounding tissues [16]. Recent studies have indicated the potential of PDT to reduce microbial load and inflammation in periodontal tissues; however, its effectiveness in orthodontic patients remains inadequately explored [17,18].

Given the unique challenges faced by individuals with FOA, there is an increasing interest in assessing the benefits of PDT as a complement to conventional oral hygiene practices for this population. While various methodologies have recently enhanced dental care for patients with FOA [19,20], the current study aimed to evaluate the effects of photodynamic laser therapy on gingival health and plaque accumulation at various time intervals during orthodontic treatment, utilizing standardized clinical indices.

Materials and Methods.

Study design and Ethics: This study employed a randomized, controlled, parallel-group trial design to evaluate the efficacy of PDT as an adjunct to oral hygiene in patients undergoing fixed orthodontic treatment. The study was conducted between September 2020 and September 2024, following ethical

approval from the Ethics Committee of the Faculty of Medicine, University of Prishtina, Prishtina, Kosovo. All participants provided written informed consent prior to enrollment.

Participants:

A total of 60 patients with fixed orthodontic appliances were recruited and randomly allocated to either the PDT group (n = 30) or the control group (n = 30). Randomization was performed using the AUSVET random number generator (epitools.ausvet.com.au). To maintain blinding, only the principal investigator (examiner) was aware of group assignments.

The sample size was calculated using epitools (https://epitools.ausvet.com.au/twomeanstwo) based on means and standard deviations of plaque index from a study conducted by Alam et al. [21]. A power of 80% and a 95% confidence level were used for the calculation in this single-blind method.

The inclusion criteria in the study were: patients over the age of 18, patients with fixed orthodontic therapy, patients who agree to participate in the study and complete the study protocol. The exclusion criteria from the study were: patients under the age of 18, patients without fixed orthodontic therapy, pregnant and lactating women and mothers who breastfeed, patients with chronic diseases, patients who are taking antibiotics in the last 10 days, patients who have undergone maxillofacial surgical interventions, patients who are taking xylitol products in the last 10 days.

Evaluation of Periodontal parameters and photodynamic laser therapy applications:

Assessments of gingival and plaque conditions were conducted at two different time intervals, we also did an intra-examiner calibration with a different group of patients. On the first day (T1), the gingival condition and dental plaque levels were evaluated using the gingival index (GI) and the dental plaque index (DPI) based on the Löe-Sillness and Sillness-Loe indexes. On the 30th day (T2), gingival and plaque conditions were re-evaluated using the GI and DPI.

In this research we used the gingival index (GI) and the dental plaque index (DPI) based on the Loe-Sillness and Sillness-Loe indexes.

The Löe Silness gingival index is used to determine the condition of the gingival tisues, and has values from 0 to 3. 0 – healthy gums (light pink color, granular structure, papillae are in the interdental space and do not protrude beyond it);1 – mild inflammation (slightly reddened gingival margin, edema and increased gingival exudate, but no bleeding from the gums); 2 – moderate inflammation (reddened gingiva, edema and increased free gingiva, bleeding on probing); 3 – severe inflammation (very reddened and greatly enlarged gingiva) [22].

The Silness Löe plaque index is used to determine the condition of the debris aggregates. and has values from 0 to 3.0 - No plaque in the gingival area; 1 - A film of plaque adhering to the free gingival margin and adjacent area of the tooth. The plaque may only be recognized by running a probe across the tooth surface; 2 - Moderate accumulation of soft deposits within the gingival pocket, on the gingival margin and/or adjacent tooth surface, which can be seen by the naked eye, 3 - Abundance of soft matter within the gingival pocket and/or on the gingival margin and adjacent tooth surface [22].

The test group was administered PDT with methylene blue while using a Laser Diode with a wavelength of 660 nm and a power of 10 mW, that emits red light, for one minute [23]. The photosynthesizing substance is methylene blue 1%. We applied this substance to all tooth surfaces and soft tissues of all teeth with fixed therapy (gingiva and gingival crevice). Since the Control group is a placebo, the laser was not activated but only passed through the teeth and gingiva for 1 minute, while in the Test group the laser was activated for 1 minute, passing through all teeth and the gingiva of all teeth.

Statistical analysis:

Statistical analysis was performed using SPSS (IBM Corp., Armonk, NY, USA). Descriptive statistics (mean, standard deviation, median, interquartile range, frequencies, and percentages) were used to summarize the data. The normality of data distribution was assessed using Shapiro-Wilk test. Independent Samples T-tests were used to compare GI and PI scores between the PDT and control groups at each time point (T1 and T2). To analyze changes in GI and PI scores over time within each group and between groups, a repeated measures ANOVA was performed, with time (T1 and T2) as the within-subjects factor and treatment group (PDT or control) as the between-subjects factor.

Results.

From the whole number of patients 68.3% were Female. The youngest patients examined was 19 years old, while the oldest was 38 years old, the mean age of the participants was 24.4±4.3.

In Table 1 we see the gender representation according to the group age of the patients. In the male patients you can see that the group age from 18 to 20 years old and 21 to 25 years old were represented each by 36.8%, while the group age of 26 to 30 years old were represented by 26.3%

In the female gender we see that 46.3% of the patients were in the group age from 21 to 25 years old, 26.8% in the group age 26 to 30 years old, with a percentage of 17.1 we found the participation of 18 to 20 years old, while the two group ages 31 to 35 years old and 36 to 40 years old were represented each by 4.9%.

In table 2 we have divided the GI according to control or testing group, on the first day of examination T1, before photodynamic therapy application. In the control group we found that 60% from the total number of examined had mild inflammation, while 30% had normal gingiva and only 10% of the examined patients had moderate inflammation. In the test group 50% of the examined had mild inflammation, 36.7% had normal gingiva and only 13.3% had moderate inflammation. We found no significant difference for $p<0.05$ using the Independent Samples T-Test.

In table 3 we see the GI values after 30 days after photodynamic therapy. We see similar percentage in the control group 60% mild inflammation, 30% normal gingiva and 10 % moderate inflammation, while in the testing group we see a difference where 50% of the examined have shown normal gingiva, 43.3% mild inflammation and 6.7% moderate inflammation. Even after this change we found no significant difference for $p<0.05$ using the Independent Samples T-Test.

Table 1. *Gender according to group age.*

Gender according to group age							
			Group Age				Total
			From 18 to 20 years old	From 21 to 25 years old	From 26 to 30 years old	From 31 to 35 years old	From 36 to 40 years old	
Gender	Male	Count	7	7	5	0	0	19
		% within Gender	36.8%	36.8%	26.3%	0.0%	0.0%	100.0%
		% within Group Age	50.0%	26.9%	31.3%	0.0%	0.0%	31.7%
		% of Total	11.7%	11.7%	8.3%	0.0%	0.0%	31.7%
	Female	Count	7	19	11	2	2	41
		% within Gender	17.1%	46.3%	26.8%	4.9%	4.9%	100.0%
		% within Group Age	50.0%	73.1%	68.8%	100.0%	100.0%	68.3%
		% of Total	11.7%	31.7%	18.3%	3.3%	3.3%	68.3%
Total		Count	14	26	16	2	2	60
		% within Gender	23.3%	43.3%	26.7%	3.3%	3.3%	100.0%
		% within Group Age	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	23.3%	43.3%	26.7%	3.3%	3.3%	100.0%

Table 2. *Gingival Index according to Loe Sillness compared to intervene group T1.*

Gingival Index according to Loe Sillness compared to intervene group T1						
			Gingival Index according to Loe Sillness			Total
			Normal Gingiva	Mild Inflammation	Moderate Inflammation	
Group	Control	Count	9	18	3	30
		% within Group	30.0%	60.0%	10.0%	100.0%
		% within Gingival Index according to Loe Sillness	45.0%	54.5%	42.9%	50.0%
		% of Total	15.0%	30.0%	5.0%	50.0%
	Test	Count	11	15	4	30
		% within Group	36.7%	50.0%	13.3%	100.0%
		% within Gingival Index according to Loe Sillness	55.0%	45.5%	57.1%	50.0%
		% of Total	18.3%	25.0%	6.7%	50.0%
Total		Count	20	33	7	60
		% within Group	33.3%	55.0%	11.7%	100.0%
		% within Gingival Index according to Loe Sillness	100.0%	100.0%	100.0%	100.0%
		% of Total	33.3%	55.0%	11.7%	100.0%

In Table 4 and 5 we see the differences in the values obtained while comparing the effect of photodynamic therapy or control in the GI, we compared the results of the two examined times T1 and T2 according to the intervened group, using repeated measures data with Anova, where we found significant differences for $p<0.05$. This difference was found in all the patients since all participants improved after the intervention, but also in the factor and group interaction, where the intervention had different effects by group, where this difference is significant by $p=0.009$ as shown on table 4. When we compared the overall differences in periodontal index between groups, regardless of group we found no significant difference in the periodontal index between the intervention and control groups overall, as shown on table 5.

In T1 we evaluated the DPI before photodynamic therapy/ placebo application, as shown in table 6. In this timeline after DPI in the control group we found that the film of plaque adhering to the free gingival margin was identified in 46.7% of the patients, moderate accumulation of soft deposits within the gingival pocket was found in 30% of the patients, 16.7% had no plaque and abundance of soft matter within the gingival pocket was found in 6.7% of the patients. While in the test group we

Table 3. *Gingival Index according to Loe Sillness compared to intervene group T2.*

Gingival Index according to Loe Sillness compared to intervene group T2						
			Gingival Index according to Loe Sillness B			Total
			Normal Gingiva	Mild Inflammation	Moderate Inflammation	
Group	Control	Count	9	18	3	30
		% within Group	30.0%	60.0%	10.0%	100.0%
		% within Gingival Index according to Loe Sillness after	37.5%	58.1%	60.0%	50.0%
		% of Total	15.0%	30.0%	5.0%	50.0%
	Test	Count	15	13	2	30
		% within Group	50.0%	43.3%	6.7%	100.0%
		% within Gingival Index according to Loe Sillness after	62.5%	41.9%	40.0%	50.0%
		% of Total	25.0%	21.7%	3.3%	50.0%
Total		Count	24	31	5	60
		% within Group	40.0%	51.7%	8.3%	100.0%
		% within Gingival Index according to Loe Sillness after	100.0%	100.0%	100.0%	100.0%
		% of Total	40.0%	51.7%	8.3%	100.0%

Table 4. *Tests of Within-Subjects Effects.*

Tests of Within-Subjects Effects							
Measure:							
Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
factor1	Sphericity Assumed	0.300	1	0.300	7.250	0.009	0.111
	Greenhouse-Geisser	0.300	1.000	0.300	7.250	0.009	0.111
	Huynh-Feldt	0.300	1.000	0.300	7.250	0.009	0.111
	Lower-bound	0.300	1.000	0.300	7.250	0.009	0.111
factor1 * Group	Sphericity Assumed	0.300	1	0.300	7.250	0.009	0.111
	Greenhouse-Geisser	0.300	1.000	0.300	7.250	0.009	0.111
	Huynh-Feldt	0.300	1.000	0.300	7.250	0.009	0.111
	Lower-bound	0.300	1.000	0.300	7.250	0.009	0.111
Error(factor1)	Sphericity Assumed	2.400	58	0.041			
	Greenhouse-Geisser	2.400	58.000	0.041			
	Huynh-Feldt	2.400	58.000	0.041			
	Lower-bound	2.400	58.000	0.041			

Table 5. *Tests of Between-Subjects Effects.*

Tests of Between-Subjects Effects						
Measure:						
Transformed Variable:						
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	64.533	1	64.533	85.196	0.000	0.595
Group	0.533	1	0.533	0.704	0.405	0.012
Error	43.933	58	0.757			

Table 6. *Plaque Index according to Loe Sillness compared to intervene group T1.*

Plaque Index according to Loe Sillness compared to intervene group T1							
			Plaque Index according to Loe Sillness				Total
			No plaque in the gingival area	Film of plaque adhering to the free gingival margin	Moderate accumulation of soft deposits within the gingival pocket	Abundance of soft matter within the gingival pocket	
Group	Control	Count	5	14	9	2	30
		% within Group	16.7%	46.7%	30.0%	6.7%	100.0%
		% within Plaque Index according to Loe Sillness	50.0%	53.8%	45.0%	50.0%	50.0%
		% of Total	8.3%	23.3%	15.0%	3.3%	50.0%
	Test	Count	5	12	11	2	30
		% within Group	16.7%	40.0%	36.7%	6.7%	100.0%
		% within Plaque Index according to Loe Sillness	50.0%	46.2%	55.0%	50.0%	50.0%
		% of Total	8.3%	20.0%	18.3%	3.3%	50.0%
Total		Count	10	26	20	4	60
		% within Group	16.7%	43.3%	33.3%	6.7%	100.0%
		% within Plaque Index according to Loe Sillness	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	16.7%	43.3%	33.3%	6.7%	100.0%

Table 7. *Plaque Index according to Loe Sillness compared to intervene T2.*

Plaque Index according to Loe Sillness compared to intervene T2						
			Plaque Index according to Loe Sillness after			Total
			No plaque in the gingival area	Film of plaque adhering to the free gingival margin	Moderate accumulation of soft deposits within the gingival pocket	
Group	Control	Count	5	16	9	30
		% within Group	16.7%	53.3%	30.0%	100.0%
		% within Plaque Index according to Loe Sillness after	35.7%	48.5%	69.2%	50.0%
		% of Total	8.3%	26.7%	15.0%	50.0%
	Test	Count	9	17	4	30
		% within Group	30.0%	56.7%	13.3%	100.0%
		% within Plaque Index according to Loe Sillness after	64.3%	51.5%	30.8%	50.0%
		% of Total	15.0%	28.3%	6.7%	50.0%
Total		Count	14	33	13	60
		% within Group	23.3%	55.0%	21.7%	100.0%
		% within Plaque Index according to Loe Sillness after	100.0%	100.0%	100.0%	100.0%
		% of Total	23.3%	55.0%	21.7%	100.0%

found that the film of plaque adhering to the free gingival margin was identified in 40% of the patients, moderate accumulation of soft deposits within the gingival pocket was found in 36.7% of the patients, 16.7% had no plaque and abundance of soft matter within the gingival pocket was found in 6.7% of the patients. We found no significant difference for $p<0.05$ using the Independent Samples T-Test.

In T2 we evaluated the DPI 30 days after photodynamic therapy/placebo application, as shown in table 7. In this timeline after DPI in the control group we found that the film of plaque adhering to the free gingival margin was identified in 53.3% of the patients, moderate accumulation of soft deposits within the gingival pocket was found in 30% of the patients, 16.7% had no plaque. While in the test group we found that the film of plaque

Table 8. *Tests of Within-Subjects Effects.*

Tests of Within-Subjects Effects							
Measure:							
Source		**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**
factor1	Sphericity Assumed	3.008	1	3.008	16.644	0.000	0.223
	Greenhouse-Geisser	3.008	1.000	3.008	16.644	0.000	0.223
	Huynh-Feldt	3.008	1.000	3.008	16.644	0.000	0.223
	Lower-bound	3.008	1.000	3.008	16.644	0.000	0.223
factor1 * Group	Sphericity Assumed	1.008	1	1.008	5.579	0.022	0.088
	Greenhouse-Geisser	1.008	1.000	1.008	5.579	0.022	0.088
	Huynh-Feldt	1.008	1.000	1.008	5.579	0.022	0.088
	Lower-bound	1.008	1.000	1.008	5.579	0.022	0.088
Error(factor1)	Sphericity Assumed	10.483	58	0.181			
	Greenhouse-Geisser	10.483	58.000	0.181			
	Huynh-Feldt	10.483	58.000	0.181			
	Lower-bound	10.483	58.000	0.181			

Table 9. *Tests of Between-Subjects Effects.*

Tests of Between-Subjects Effects						
Measure:						
Transformed Variable:						
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	156.408	1	156.408	162.916	0.000	0.737
Group	0.408	1	0.408	0.425	0.517	0.007
Error	55.683	58	0.960			

adhering to the free gingival margin was identified in 56.7% of the patients, 30% had no plaque, and moderate accumulation of soft deposits within the gingival pocket was found in 13.3% of the patients. We found no significant difference for $p<0.05$ using the Independent Samples T-Test.

In Table 8 and 9 we see the differences in the values obtained while comparing the effect of photodynamic therapy or control in the DPI, we compared the results of the two examined times T1 and T2 according to the intervened group, using repeated measures data with Anova, where we found significant differences for $p<0.05$. This difference was found in all the patients since all participants improved after the intervention, but also in the factor and group interaction, where the intervention had different effects by group, where this difference is significant by $p=0.009$ as shown on table 8. When we compared the overall differences in periodontal index between groups, regardless of group we found no significant difference in the periodontal index between the intervention and control groups overall, as shown on table 9.

Discussion.

Our study demonstrated a significant improvement in periodontal indices 30 days after photodynamic therapy (PDT) in patients with fixed orthodontic appliances. These findings align with existing evidence suggesting that PDT, as an adjunct to conventional periodontal treatment, effectively reduces plaque accumulation and gingival inflammation in this patient population. While recent technological advancements, particularly in artificial intelligence, are on the rise, patients with fixed orthodontic appliances face an increased risk due to the challenges associated with maintaining oral hygiene around orthodontic brackets [24-29].

The observed reduction in plaque index supports PDT's antimicrobial action against biofilm, which is often exacerbated by fixed appliances that hinder mechanical cleaning [24,26]. Similarly, the significant decrease in gingival index reflects PDT's anti-inflammatory effects, consistent with reports of lowered inflammatory cytokines and improved clinical periodontal parameters following PDT [26,28]. Clinical trials indicate that PDT as an adjunct to scaling and root planing improves clinical parameters such as plaque index, gingival index, bleeding on probing, and probing depth more effectively than mechanical treatment alone [30]. These improvements are attributed to PDT's ability to selectively destroy periodontal pathogens through reactive oxygen species generated by the interaction of a photosensitizer and light at a specific wavelength, leading to microbial reduction and decreased inflammatory cytokines such as IL-6 and TNF-α [30].

Recent studies have also explored the long-term effects of PDT in maintaining periodontal health during orthodontic treatment. A randomized controlled trial conducted by Malgikar et al. demonstrated that patients receiving PDT alongside standard oral hygiene practices exhibited sustained improvements in periodontal parameters over a six-month follow-up period. These findings suggest that PDT not only provides immediate inflammation reduction but may also contribute to the stabilization of periodontal health, reducing the risk of recurrent gingival inflammation in patients with fixed appliances [31].

Beyond its antimicrobial and anti-inflammatory effects, emerging research indicates that PDT may promote regenerative

processes within periodontal tissues. A histological study by de Almeida et al. revealed increased collagen deposition and enhanced periodontal ligament regeneration in sites treated with PDT compared to controls [32]. These regenerative effects are thought to result from PDT-induced modulation of cellular responses, including the promotion of fibroblast proliferation and angiogenesis, which may foster tissue healing and stability in orthodontic patients [32]. Furthermore, technological advances in recent years could play a crucial role in this regard [33-35].

The safety profile of PDT continues to be supported by recent evidence. A comprehensive analysis by Aebisher et al. concluded that PDT is well-tolerated with minimal adverse effects, primarily limited to transient mucosal sensitivity. This safety aspect is particularly important in orthodontic patients, who often require repeated interventions. The non-invasive nature of PDT, coupled with its minimal side effects, makes it a valuable adjunctive therapy in managing periodontal health without compromising patient safety [36].

Cost-effectiveness analyses are increasingly highlighting the practical advantages of incorporating PDT into periodontal care for orthodontic patients. A study by Elsadek and Farahat assessed the economic impact of PDT as an adjunct to conventional therapy, finding that it reduces the need for extensive periodontal interventions and lowers overall treatment costs by preventing periodontal deterioration. These findings underscore the potential of PDT not only as an effective clinical tool but also as a financially advantageous option for long-term management of periodontal health in patients undergoing orthodontic treatment [37].

Limitations.

While our study demonstrates the benefits of PDT, certain limitations should be considered. The sample size was relatively small, and future studies with larger cohorts are needed to confirm these findings. Furthermore, the follow-up period was limited to 30 days. Longer-term studies are necessary to evaluate the sustained efficacy of PDT in maintaining periodontal health during orthodontic treatment. The study also did not explore the effects of different PDT protocols (varying photosensitizer concentrations, light parameters), which may influence treatment outcomes. Finally, patient compliance with oral hygiene instructions was not directly assessed, which may influence the observed results. The lack of evaluation of participant adherence to oral hygiene practices, including brushing and flossing, represents a significant limitation in studies investigating the effects of interventions on oral health outcomes [38]. This absence of adherence data complicates the accurate attribution of observed changes in oral health to the intervention itself, as variations in individual oral hygiene practices can independently affect these outcomes.

Conclusion.

Our results reinforce the role of PDT as a safe and effective adjunctive therapy to improve periodontal health during orthodontic treatment, potentially enhancing patient outcomes by controlling gingivitis and plaque more efficiently than scaling alone. This is particularly relevant given the challenges of plaque control in orthodontic patients and the short-term nature of inflammation control with conventional methods. Future research should focus on larger, multi-center trials with longer follow-up periods to further validate these findings and optimize PDT protocols for orthodontic patients.

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