Original Research

https://doi.org/10.36377/ET-0120

Analysis of the surface microbiome of removable orthodontic appliances cleaned with various hygiene products

Anna K. Koledaeva ✉, Alexandra V. Zaynutdinova, Tatyana V. Karavaeva, Ekaterina P. Kolevatykh, Anton V. Elikov, Elizaveta A. Kuklina, Svetlana N. Gromova, Olga A. Maltseva, Vladimir A. Razumny

Kirov State Medical University, Kirov, Russian Federation

✉ aniuiri@gmail.ru

Abstract

AIM. The aim of this study is to investigate the differences in the microbiota of the surface of orthodontic plates depending on the used hygiene products.

MATERIALS AND METHODS. The study was attended by 36 patients aged 6 to 12 years, undergoing treatment on removable orthodontic equipment using various hygiene products. The study was carried out using the determination of the prosthesis hygiene index and microbiological analysis of the material from the surface of the plate. Statistically, the data analysis included a description of the accounting features, an assessment of the statistical significance of changes in the indicators under study.

RESULTS. In the structure of the biofilm of a removable plate, microbiological indicators before and after the experiment showed a pronounced, statistically significant negative dynamics. And also, an improvement in the hygiene index of the plate and oral cavity.

CONCLUSIONS. The use of various hygiene products with orthodontic patients and the study of the microbiological status of the surface of the plate after cleaning them will allow you to choose the most optimal option for cleansing the removable apparatus.

Keywords: removable orthodontic plate, microbiological analysis, biofilm, hygiene products

Article info: received – 20.06.2025; revised – 22.07.2205; accepted – 07.08.2025

Conflict of interest: The authors report no conflict of interest.

Acknowledgements: There are no funding and individual acknowledgments to declare.

For citation: Koledaeva A.K., Zaynutdinova A.V., Karavaeva T.V., Kolevatykh E.P., Elikov A.V., Kuklina E.A., Gromova S.N., Maltseva O.A., Razumny V.A. Analysis of the surface microbiome of removable orthodontic appliances cleaned with various hygiene products. *Endodontics Today.* 2025;23(3):473–479. https://doi.org/10.36377/ET-0120

Анализ микробиома поверхности съемных ортодонтических пластинок, обработанных различными средствами гигиены

А.К. Коледаева ✉, А.В. Зайнутдинова, Т.В. Караваева, Е.П. Колеватых, А.В. Еликов, Е.А. Куклина, С.Н. Громова, О.А. Мальцева, В.А. Разумный

Кировский государственный медицинский университет, г. Киров, Российской Федерации

✉ aniuiri@gmail.ru

Резюме

ЦЕЛЬ. Изучить различия микробиома поверхности ортодонтических пластинок в зависимости от используемых средств гигиены.

МАТЕРИАЛЫ И МЕТОДЫ. В исследовании приняли участие 36 пациентов в возрасте от 6 до 12 лет с диагнозом К07.2 Аномалии соотношения зубных дуг, получающие лечение с использованием съемной ортодонтической аппаратуры с учетом применения различных средств гигиены полости рта. Исследование проведено с помощью определения индекса гигиены протеза и микробиологического анализа материала с поверхности пластинки. Статистически анализ данных включал описание учетных признаков, оценку статистической значимости изменений изучаемых показателей.

РЕЗУЛЬТАТЫ. В структуре биофильма съемной пластинки микробиологические показатели до и после эксперимента показали выраженную, статистически значимую отрицательную динамику. А также произошло снижение индекса гигиены пластинки и полости рта.

ВЫВОДЫ. Применение различных средств гигиены ортодонтическими пациентами и изучение микробиологического статуса поверхности пластинки после их чистки позволит выбрать наиболее оптимальный вариант очищения съемного аппарата.

Ключевые слова: съемный пластиночный аппарат, микробиологическое исследование, биопленка, средства гигиены

© Koledaeva A.K., Zaynutdinova A.V., Karavaeva T.V., Kolevatykh E.P., Elikov A.V., Kuklina E.A., Gromova S.N., Maltseva O.A., Razumny V.A., 2025

Информация о статье: поступила – 20.06.2025; исправлена – 22.07.2205; принята – 07.08.2025

Конфликт интересов: авторы сообщают об отсутствии конфликта интересов.

Благодарности: финансирование и индивидуальные благодарности для декларирования отсутствуют.

Для цитирования: Коледаева А.К., Зайнутдинова А.В., Караваева Т.В., Колеватых Е.П., Еликов А.В., Куклина Е.А., Громова С.Н., Мальцева О.А., Разумный В.А. Анализ микробиома поверхности съемных ортодонтических пластинок, обработанных различными средствами гигиены. *Эндодонтия Today.* 2025;23(3):473–479. https://doi.org/10.36377/ET-0120

INTRODUCTION

According to the World Health Organization (WHO), as of 2023, oral health problems are among the most prevalent non-communicable diseases globally, accounting for nearly 3.5 billion cases. Oral diseases affect approximately 45% of the world's population, indicating a significant deficiency in preventive measures. The prevention of pathological processes in the oral cavity includes oral hygiene education, pharmacological prophylaxis, and timely treatment interventions[1].

An epidemiological survey conducted in Russia in 2019 revealed that among six-year-old children, the prevalence of caries in permanent teeth, based on the DMFT index, was 2%. The components of the index were as follows: Decayed (D) – 0.02%, Missing (M) – 0.00%, and Filled (F) – 0.00%. At the age of 12, caries prevalence reached 72%, with a mean caries experience of 2.38%, the mean number of filled teeth at 0.52%, and extracted teeth at 0.02%. Among 15-year-olds, the prevalence of carious lesions increased to 82%, with the D component at 1.58%, F – 1.38%, and M – 0.04%. Periodontal health was reported in 90% of 12-year-olds and 74% of 15-year-olds.

In the city of Kirov, according to epidemiological dental assessments conducted in 2019 and 2022, the number of 12- and 15-year-old children diagnosed with periodontal tissue pathology increased. Among 12-year-olds, the proportion of children without periodontal lesions was higher than the national average, whereas in the 15-year-old group, the figure was lower, with more frequent occurrences of bleeding on probing and the presence of dental calculus. These indicators exceed the national average and reflect insufficient routine oral hygiene practices [1; 2].

Studies conducted across various regions of Russia have shown that among all dental pathologies, dentoalveolar anomalies (DAAs) occur in 41.5% to 69.9% of cases, with approximately every second patient using removable orthodontic appliances for occlusal correction. Over the past 20 years, the prevalence of DAAs has increased by approximately 25%. According to national epidemiological data, the incidence of dentoalveolar system disorders among children varies from 37.8 to 85%, depending on the developmental stage of the jaws and the phase of occlusion formation [3].

[1] Pan American Health Organization. Global oral health status report: Towards universal health coverage for oral health by 2030. Washington, D.C.: PAHO/WHO; 2022. Available at: https://www.paho.org/en/documents/global-oral-health-status-report-towards-universal-health-coverage-oral-health-2030 (accessed: 01.06.2025).

Research indicates that around 30–40% of patients experience discomfort when wearing removable plate-type orthodontic appliances [4]. These devices are often perceived by the body as foreign objects, leading to irritation of the oral mucosa. Improved adaptation and a reduction in inflammatory reactions can be achieved through effective cleaning of the appliance. Prolonged use of such prostheses–particularly in the absence of adequate hygiene–allows microbial biofilms originating from dental plaque to penetrate up to 2–2.5 mm into the acrylic base of the plate [5].

The microbial species most commonly found in the biofilm on orthodontic appliances include *Staphylococcus aureus*, *Streptococcus* spp. (*S. mutans*, *S. mitis*, *S. sanguis*, *S. salivarius*), *Candida* yeasts, and various periodontopathogens such as *Aggregatibacter actinomycetemcomitans*, *Porphyromonas gingivalis*, *Porphyromonas endodontalis*, *Prevotella intermedia*, *Tannerella forsythia*, and *Treponema denticola* [6].

Therefore, the selection of optimal hygiene products for cleaning orthodontic appliances remains a relevant and important issue in contemporary orthodontic practice.

AIM

The aim of this study is to perform a comparative evaluation of the microbiota associated with removable orthodontic appliances following two different hygiene protocols: mechanical cleaning using toothpaste and a toothbrush, and chemical cleaning using a specialized active oxygen-based agent. Additionally, the study seeks to assess the impact of appliance usage on the biochemical composition of oral fluid in orthodontic patients.

MATERIALS AND METHODS

The study was conducted with the participation of 36 patients aged 6 to 12 years undergoing treatment with removable orthodontic appliances. The patients were divided into two groups of 15 individuals each. The first group included orthodontic patients who used a specialized active oxygen-based hygiene product for appliance cleaning. The second group, serving as the control, included patients who used a medium-bristled toothbrush and conventional toothpaste for cleaning.

During the study, the prosthesis hygiene index (Tarbet modification) was recorded, oral fluid was collected for biochemical analysis, and biofilm samples were taken from the surface of the orthodontic appliances for microbiological evaluation using polymerase chain reaction (PCR). These parameters were assessed on

day 1 and day 30 of appliance cleaning using either conventional toothpaste/soap or oxygen-based cleansing tablets, respectively.

To assess the modified Tarbet index, the orthodontic appliance was removed from the oral cavity and immersed in water for one minute to eliminate food debris. The tissue-facing surface of the appliance was stained with erythrosine solution for one minute, after which the dye was rinsed off. The amount of plaque was evaluated based on the stained surface area and color intensity.

Unstimulated whole saliva samples were collected in the morning on an empty stomach, prior to toothbrushing, by passive drooling into sterile disposable tubes (5 mL per patient). The biochemical analysis of calcium ions (Ca^{2+}), phosphate (PO_4^{3-}), and total protein content in the saliva was conducted using photocolorimetric methods with reagent kits "Calcium-2-Olvex" and "FN-Olvex". The hydrogen ion concentration (pH) of the saliva was measured using a HI98103 Checker pH Tester (Hanna Instruments, Romania). Total antioxidant activity was determined by induced chemiluminescence, a method based on the assessment of free radical reaction activity in the sample [7]. Salivary pH was additionally measured using the "Expert-001" pH meter [8].

Microbial samples were collected from the appliance surface using sterile paper points, placed into saline solution, and transported to a microbiological laboratory. Serial tenfold dilutions were prepared using buffer solution and plated on meat-peptone agar (MPA) in Petri dishes, followed by incubation at 37°C and colony counting. DNA of periodontal pathogens was extracted using the "ProbaGS" kit (LLC "DNA-Technology"), in accordance with the manufacturer's protocol, and analyzed by real-time PCR using a DT-96 thermocycler (LLC "DNA-Technology"). The results were evaluated using the instrument's software. Based on the cycle threshold (Ct), the total microbial count was determined, expressed in colony-forming units per milliliter (CFU/mL), including the quantity of mesophilic aerobic and facultative anaerobic bacteria. Specific periodontal pathogens were identified, including *Aggregatibacter actinomycetemcomitans*, *Porphyromonas gingivalis*, *Prevotella intermedia*, *Treponema denticola*, and *Tannerella forsythia*. The microbial composition was categorized into microbial complexes according to the classification by S.S. Socransky [7; 9].

To monitor the cleanliness of the appliance surface, a photoprotocol was performed using a light electron microscope (×8 magnification) before and after cleaning with oxygen-releasing tablets.

RESULTS

In the first and second groups, the DMFT+dmft index was 4.25±0.48 and 5.25±0.63, respectively, which is considered a moderate level and falls within the relative norm for the 6–12 age group.

At the beginning of the study, the prosthesis hygiene index (modified Tarbet) in the two groups averaged 3.5±0.29 and 3.75±0.25 points, respectively. After 30 days of appliance cleaning, the index decreased to 1.8±0.48 points in the group using toothpaste/soap and to 0.8±0.25 points in the group using oxygen-releasing tablets, indicating superior efficacy of the latter. Visually, the intensity of staining on the appliances was significantly reduced, not exceeding 25% of the plate surface.

Biochemical analysis of oral fluid in the control and experimental groups did not reveal statistically significant differences. In Group 1, the salivary pH was 7.28±0.24 at baseline and 7.03±0.02 at the end of the experiment ($p=0.07$); in Group 2, it was 7.61±0.26 and 7.59±0.27, respectively ($p=0.64$) (Fig. 1). The differences in both groups were not statistically significant. A slight shift toward acidity was observed in the control group, whereas Group 2 maintained a consistently alkaline environment in the oral cavity. Total protein levels in oral fluid decreased steadily in both groups, indicating reduced salivary viscosity and, consequently, improved oral self-cleansing, associated with regular hygiene of orthodontic appliances regardless of the cleansing method used.

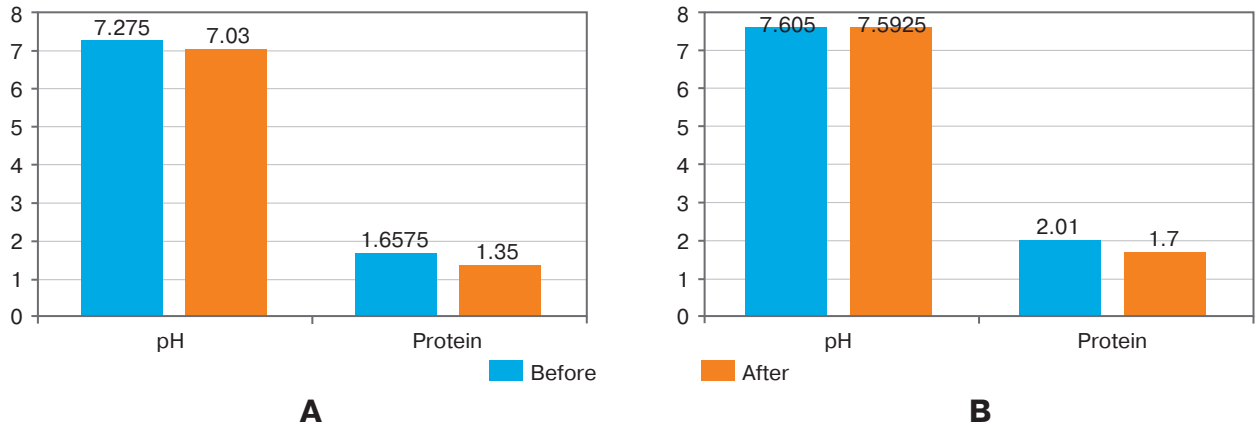

Fig. 1. Changes in biochemical parameters in the control group (*A*) and the group of patients using an oxygen hygiene product (*B*)

Рис. 1. Изменения биохимических показателей в контрольной группе (*A*) и группе пациентов, использующих кислородсодержащее средство гигиены (*B*)

The total microbial count (TMC) in the control group increased threefold after one month of cleaning with toothpaste: prior to the intervention, the microbial load was $(1.00 \pm 0.1) \times 10^7$ CFU/mL, while after the intervention it reached $(3.03 \pm 2.33) \times 10^7$ CFU/mL. In contrast, the experimental group showed a statistically significant ($p \leqslant 0.05$) twofold reduction in TMC. At baseline, the microbial count was $(5.50 \pm 2.6) \times 10^5$ CFU/mL, and after one month of appliance cleaning with the specialized hygiene agent, it decreased to $(3.25 \pm 2.25) \times 10^4$ CFU/mL, demonstrating the effectiveness of the active oxygen-based product (Fig. 2).

According to PCR analysis, a significant increase in the number of periodontal pathogens was observed in the control group. The microbial load on the appliances used by control group patients before and after the intervention, respectively, was as follows: *Aggregatibacter actinomycetemcomitans* $[(2.80 \pm 2.41) \times 10^3$ and $(3.25 \pm 1.00) \times 10^4$ CFU/mL, $p < 0.05]$, *Porphyromonas gingivalis* $[(2.80 \pm 2.41) \times 10^3$ and $(7.75 \pm 2.25) \times 10^4$ CFU/mL, $p < 0.05]$, *Porphyromonas endodontalis* $[(3.00 \pm 2.34) \times 10^3$ and $(5.25 \pm 2.75) \times 10^4$ CFU/mL, $p < 0.05]$, *Prevotella intermedia* $[(2.80 \pm 2.41) \times 10^3$ and $(2.80 \pm 2.41) \times 10^4$ CFU/mL, $p < 0.05]$, *Tannerella forsythia* $[(2.76 \pm 2.43) \times 10^2$ and $(2.78 \pm 2.42) \times 10^4$ CFU/mL, $p < 0.05]$, and *Treponema denticola* $[(2.76 \pm 2.43) \times 10^2$ and $(3.25 \pm 2.25) \times 10^2$ CFU/mL, $p = 0.65]$. An increase in *Candida albicans* colonization was also observed $[(3.03 \pm 2.33) \times 10^3$ and $(5.05 \pm 2.60) \times 10^3$ CFU/mL, $p = 0.14]$, possibly due to the observed decrease in salivary pH. In parallel, a marked decline in the quantity of *Lactobacillus* spp. – representatives of the normal oral microbiota – was noted, which is considered a negative factor for oral health (Fig. 3).

In contrast, PCR analysis in the experimental group demonstrated a reduction in the levels of periodontal pathogens alongside an increase in *Lactobacillus* spp. counts. Specifically, the microbial concentrations before and after the intervention were as follows: *Aggregatibacter actinomycetemcomitans* $[(5.50 \pm 2.60) \times 10^2$ and $(3.25 \pm 2.25) \times 10^2$ CFU/mL, $p < 0.05]$, *Porphyromonas gingivalis* $[(5.50 \pm 2.60) \times 10^2$ and $(7.75 \pm 2.25) \times 10^1$ CFU/mL, $p < 0.05]$, *Porphyromonas endodontalis* $[(3.25 \pm 2.25) \times 10^2$ and $(7.75 \pm 2.25) \times 10^1$ CFU/mL, $p < 0.05]$, *Prevotella intermedia* $[(5.50 \pm 2.60) \times 10^2$ and $(3.25 \pm 2.25) \times 10^1$ CFU/mL, $p < 0.05]$, *Tannerella forsythia* $[(3.00 \pm 2.34) \times 10^2$ and $(7.75 \pm 2.25) \times 10^1$ CFU/mL, $p < 0.05]$, *Treponema denticola* $[(2.75 \pm 2.43) \times 10^3$ and $(5.28 \pm 2.73) \times 10^1$ CFU/mL, $p < 0.05]$, and *Candida albicans* $[(2.80 \pm 2.60) \times 10^3$ and $(5.50 \pm 2.49) \times 10^2$ CFU/mL, $p < 0.05]$ (Fig. 4).

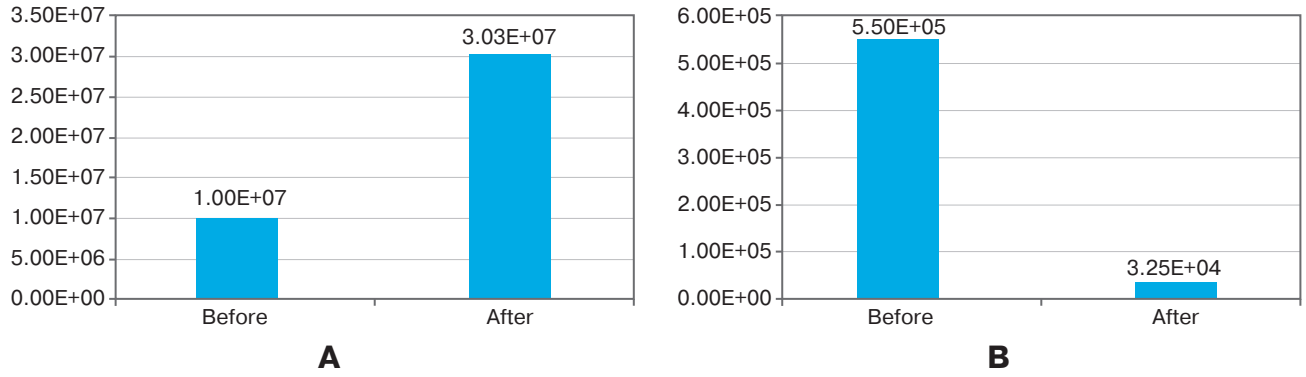

Fig. 2. Total microbial number in control (*A*) and experimental (*B*) groups before and after examination, in CFU/ml

Рис. 2. Общее микробное число в контрольной (*A*) и экспериментальной (*B*) группах до и после эксперимента, в КОЕ/мл

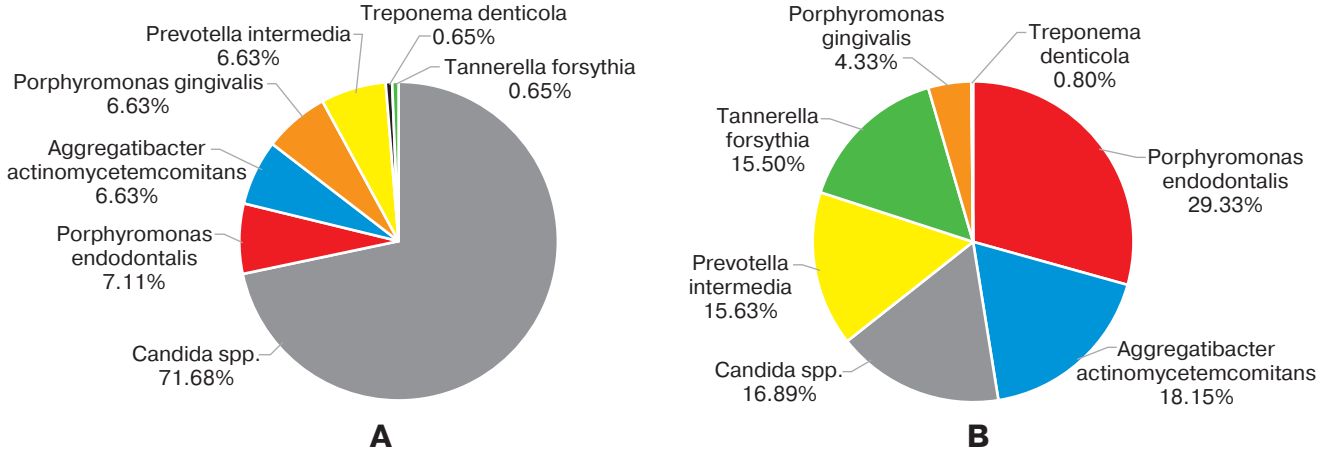

Fig. 3. PCR studies data in the control group before (*A*) and after (*B*) investigation

Рис. 3. ПЦР исследование в контрольной группе до (*A*) и после (*B*) исследования

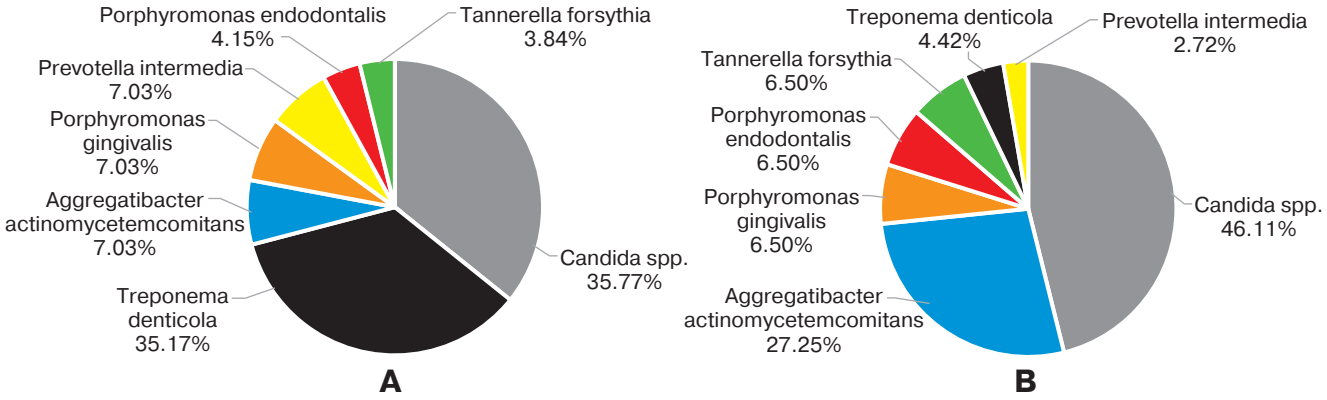

Fig. 4. PCR studies data in the experimental group before (*A*) and after (*B*) investigation

Рис. 4. ПЦР исследование в экспериментальной группе до (*A*) и после (*B*) исследования

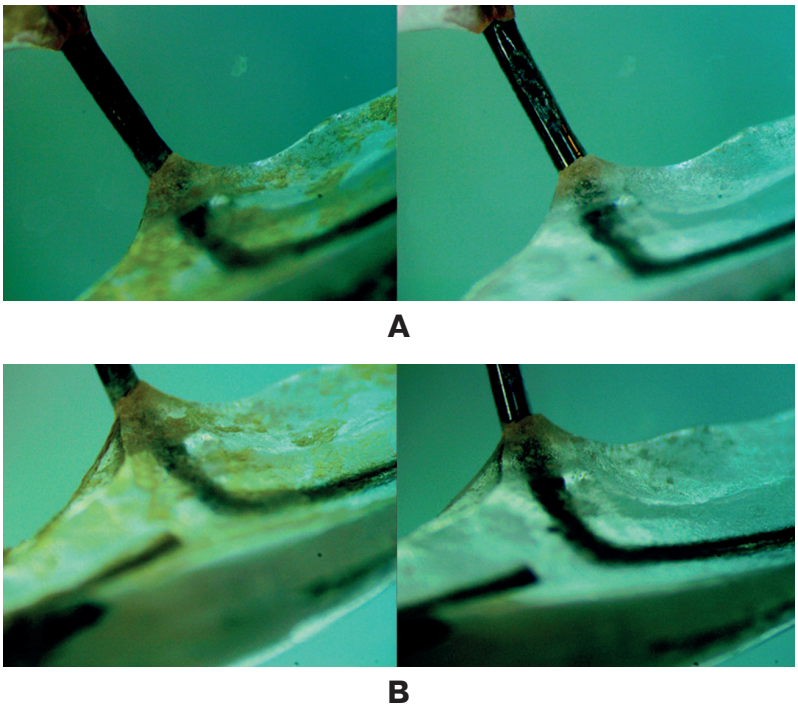

Fig. 5. Photos of an orthodontic structure taken on a scanning electron microscope (magnification x8) before (*A*) and after (*B*) cleaning with oxygen-containing tablets

Рис. 5. Фото ортодонтической конструкции, сделанные на сканирующем электронном микроскопе (увеличение x8) до (*A*) и после (*B*) чистки кислородсодержащими таблетками

The photodocumentation performed before and after treatment of the orthodontic appliances with the oxygen-releasing agent, using a scanning electron microscope at ×8 magnification, visually confirmed a reduction in biofilm coverage and plaque accumulation (Fig. 5).

CONCLUSIONS

1. More effective plaque removal from removable orthodontic appliances, as assessed by the Tarbet index, was achieved using an active oxygen-based cleansing agent compared to conventional cleaning with a toothbrush and toothpaste.

2. Biochemical analysis demonstrated that the absence of significant differences in salivary pH and the reduction in total protein content in both the experimental and control groups were attributable not to the composition of the hygiene products, but rather to the overall improvement in appliance and oral hygiene practices.

3. Microbiological examination of biofilm from the appliance surface revealed that maintaining hygienic conditions is more effective with regular use of an active oxygen-based cleansing agent, resulting in a twofold reduction in total microbial count and a 75% decrease in biofilm surface area. Therefore, the use of such specialized products should be recommended as part of routine care for removable orthodontic appliances.

REFERENCES / СПИСОК ЛИТЕРАТУРЫ

1. Gromova S.N., Medvedeva M.S., Kaysina T.N., Gromova O.A., Kreneva V.A., Ryabova O.Sh. et al. Epidemiological status of children in Kirov in 2022 according to WHO criteria (2013). *Vyatskiy Meditsinskiy Vestnik*. 2023;(4):69–73. (In Russ.) https://doi.org/10.24412/2220-7880-2023-4-69-73
   Громова С.Н., Медведева М.С., Кайсина Т.Н., Громова О.А., Кренева В.А., Рябова О.Ш. и др. Эпидемиологический статус детей города Кирова в 2022 году по критериям ВОЗ (2013). *Вятский медицинский вестник*. 2023;(4):69–73. https://doi.org/10.24412/2220-7880-2023-4-69-73
2. Kuzmina E.M., Yanushevich O.O., Kuzmina I.N., Petrina E.S., Vasina S.A., Benya V.N., Lapatina A.V. *Dental morbidity of the population of Russia*. Moscow: Russian University of Medicine; 2019. 304 p. (In Russ.)
   Кузьмина Э.М., Янушевич О.О., Кузьмина И.Н., Петрина Е.С., Васина С.А., Беня В.Н., Лапатина А.В. *Стоматологическая заболеваемость населения России*. М.: Российский университет медицины; 2019. 304 с.
3. Gazhva S.I., Krasnokutskaya N.S., Kasumov R.S. Epidemiological aspects and clinical results of orthodontic treatment of children from 7 to 12 years old. *Pulse*. 2021;23(3):66–73. (In Russ.) https://doi.org/10.26787/nydha-2686-6838-2021-23-3-66-73
   Гажва С.И., Краснокутская Н.С., Касумов Р.С. Эпидемиологические аспекты и клинические результаты ортодонтического лечения детей от 7 до 12 лет. *Пульс*. 2021;23(3):66–73. https://doi.org/10.26787/nydha-2686-6838-2021-23-3-66-73
4. Shurygin K.N., Matveev R.S., Khanbikov B.N. Problems of adaptation to removable prostheses in patients of different age groups. *Acta Medica Eurasica*. 2023;(2):53–59. (In Russ.) https://doi.org/10.47026/2413-4864-2023-2-53-59
   Шурыгин К.Н., Матвеев Р.С., Ханбиков Б.Н. Проблемы адаптации пациентов различных возрастных групп к съемным протезам. *Acta Medica Eurasica*. 2023;(2):53–59. https://doi.org/10.47026/2413-4864-2023-2-53-59
5. Bizyaev A.A., Konnov V.V., Pospelov A.N., Krechetov S.A., Maslennikov D.N., Proshin A.G. Features of hygienic care for removable prostheses made of thermoplasts. *Challenges in Modern Medicine*. 2024;47(1):64–71. (In Russ.) https://doi.org/10.52575/2687-0940-2024-47-1-64-71
   Бизяев А.А., Коннов В.В., Поспелов А.Н., Кречетов С.А., Масленников Д.Н., Прошин А.Г. Особенности гигиенического ухода за съемными протезами из термопластов. *Актуальные проблемы медицины*. 2024;47(1):64–71. https://doi.org/10.52575/2687-0940-2024-47-1-64-71
6. Rubtsova E.A., Chirkova N.V., Polushkina N.A., Kartavtseva N.G., Vecherkina Zh.V., Popova T.A. Evaluation of the microbiological examination of removable dentures of thermoplastic material. *Journal of New Medical Technologies*. 2017;(2):267–270. (In Russ.) Available at: http://www.medtsu.tula.ru/VNMT/Bulletin/E2017-2/3-5.pdf (accessed: 01.06.2025).
   Рубцова Е.А., Чиркова Н.В., Полушкина Н.А., Картавцева Н.Г., Вечеркина Ж.В., Попова Т.А. Оценка микробиологического исследования съемных зубных протезов из термопластического материала. *Вестник новых медицинских технологий*. 2017;(2):267–270. Режим доступа: http://www.medtsu.tula.ru/VNMT/Bulletin/E2017-2/3-5.pdf (дата обращения: 01.06.2025).
7. Kaisina T.N., Gromova S.N., Kolevatykh E.P., Elikov A.V., Leushina E.A., Kushkova N.E. et al. Dentistry Status Features of Patients with Non-alcoholic Fatty Liver Disease. *Ural Medical Journal*. 2025;24(2):7–20. (In Russ.) https://doi.org/10.52420/umj.24.2.7
   Кайсина Т.Н., Громова С.Н., Колеватых Е.П., Еликов А.В., Леушина Е.А., Кушкова Н.Е. и др. Особенности стоматологического статуса пациентов с неалкогольной жировой болезнью печени. *Уральский медицинский журнал*. 2025;24(2):7–20. https://doi.org/10.52420/umj.24.2.7
8. Koledaeva E.V., Kozvonin V.A., Koledaeva A.K., Zhukova E.D. Influence of antioxidant activity and oral fluid acidity on the vegetation of *Aggregatibacter actinomycetemcomitans*. *Vyatskiy Meditsinskiy Vestnik*. 2021;(1):73–76. (In Russ.)
   Коледаева Е.В., Козвонин В.А., Коледаева А.К., Жукова Е.Д. Влияние антиоксидантной активности и кислотности ротовой жидкости на вегетацию бактерий *Aggregatibacter actinomycetemcomitans*. *Вятский медицинский вестник*. 2021;(1):73–76.
9. Socransky S.S. Criteria for the infectious agents in dental caries and periodontal disease. *J Clin Periodontol*. 1979;6(7):16–21. https://doi.org/10.1111/j.1600-051x.1979.tb02114.x

INFORMATION ABOUT THE AUTHORS

Anna K. Koledaeva – Assistant of Dentistry Department, Kirov State Medical University, 112 Vladimirskaya Str., Kirov 610027, Russian Federation; https://orcid.org/0000-0001-8658-2387

Alexandra V. Zaynutdinova – Student of the Dentistry Department, Kirov State Medical University, 112 Vladimirskaya Str., Kirov 610027, Russian Federation; https://orcid.org/0009-0005-9922-5879

Tatyana V. Karavaeva – Student of Dentistry Department, Kirov State Medical University, 112 Vladimirskaya Str., Kirov 610027, Russian Federation; https://orcid.org/0009-0006-3246-2324

Ekaterina P. Kolevatykh – Cand. Sci. (Med.), Associate Professor, Head of the Department of Microbiology and Virology, Kirov State Medical University, 112 Vladimirskaya Str., Kirov 610027, Russian Federation; https://orcid.org/0000-0001-6147-3555

Anton V. Elikov – Cand. Sci. (Med.), Associate Professor of the Department of Biochemistry, Kirov State Medical University, 112 Vladimirskaya Str., Kirov 610027, Russian Federation; https://orcid.org/0000-0002-3042-8556

Elizaveta A. Kuklina – Cand. Sci. (Med.), Senior Lecturer of Dentistry Department, Kirov State Medical University, 112 Vladimirskaya Str., Kirov 610027, Russian Federation; https://orcid.org/0000-0003-3952-6205

Svetlana N. Gromova – Cand. Sci. (Med.), Associate Professor, Associate Professor Head of the Department of Dentistry, Dean of the Dentistry Department, Kirov State Medical University, 112 Vladimirskaya Str., Kirov 610027, Russian Federation; https://orcid.org/0000-0001-6686-5689

Olga A. Maltseva – Cand. Sci. (Med.), Associate Professor, Associate Professor of Dentistry Department, Kirov State Medical University, 112 Vladimirskaya Str., Kirov 610027, Russian Federation; https://orcid.org/0000-0002-4941-3485

Vladimir A. Razumny – Cand. Sci. (Med.), Professor of Dentistry Department, Kirov State Medical University, 112 Vladimirskaya Str., Kirov 610027, Russian Federation; https://orcid.org/0009-0009-1230-8348

ИНФОРМАЦИЯ ОБ АВТОРАХ

Коледаева Анна Константиновна – ассистент кафедры стоматологии, аспирант, ФГБОУ ВО «Кировский государственный медицинский университет», 610027, Российская Федерация, г. Киров, ул. Владимирская, д. 112; https://orcid.org/0000-0001-8658-2387

Зайнутдинова Александра Валерьевна – студент 3 курса стоматологического факультета, ФГБОУ ВО «Кировский государственный медицинский университет», 610027, Российская Федерация, г. Киров, ул. Владимирская, д. 112; https://orcid.org/0009-0005-9922-5879

Караваева Татьяна Владимировна – студент 3 курса стоматологического факультета, ФГБОУ ВО «Кировский государственный медицинский университет», 610027, Российская Федерация, г. Киров, ул. Владимирская, д. 112; https://orcid.org/0009-0006-3246-2324

Колеватых Екатерина Петровна – к.м.н., доцент, заведующий кафедрой микробиологии и вирусологии, ФГБОУ ВО «Кировский государственный медицинский университет», 610027, Российская Федерация, г. Киров, ул. Владимирская, д. 112; https://orcid.org/0000-0001-6147-3555

Еликов Антон Вячеславович – к.м.н., доцент кафедры биохимии, ФГБОУ ВО «Кировский государственный медицинский университет», 610027, Российская Федерация, г. Киров, ул. Владимирская, д. 112; https://orcid.org/0000-0002-3042-8556

Куклина Елизавета Александровна – к.м.н., старший преподаватель кафедры стоматологии, ФГБОУ ВО «Кировский государственный медицинский университет», 610027, Российская Федерация, г. Киров, ул. Владимирская, д. 112; https://orcid.org/0000-0003-3952-6205

Громова Светлана Николаевна – к.м.н., доцент, заведующий кафедрой стоматологии, декан стоматологического факультета, ФГБОУ ВО «Кировский государственный медицинский университет», 610027, Российская Федерация, г. Киров, ул. Владимирская, д. 112; https://orcid.org/0000-0001-6686-5689

Мальцева Ольга Александровна – к.м.н., доцент, доцент кафедры стоматологии, ФГБОУ ВО «Кировский государственный медицинский университет», 610027, Российская Федерация, г. Киров, ул. Владимирская, д. 112; https://orcid.org/0000-0002-4941-3485

Разумный Владимир Анатольевич – д.м.н., профессор кафедры стоматологии, ФГБОУ ВО «Кировский государственный медицинский университет», 610027, Российская Федерация, г. Киров, ул. Владимирская, д. 112; https://orcid.org/0009-0009-1230-8348

AUTHOR'S CONTRIBUTION

Anna K. Koledaeva – has made a substantial contribution to the concept or design of the article; drafted the article or revised it critically for important intellectual content.

Alexandra V. Zaynutdinova – the acquisition, statistical processing of materials, acquisition, analysis, or interpretation of data for the article.

Tatyana V. Karavaeva – the acquisition, analysis, or interpretation of data for the article.

Ekaterina P. Kolevatykh – microbiological research, acquisition, analysis, or interpretation of data for the article.

Anton V. Elikov – biochemical research, acquisition, analysis, or interpretation of data for the article.

Elizaveta A. Kuklina – drafted the article or revised it critically for important intellectual content.

Svetlana N. Gromova – approved the version to be published.

Olga A. Maltseva – approved the version to be published.

Vladimir A. Razumny – approved the version to be published.

ВКЛАД АВТОРОВ

А.К. Коледаева – существенный вклад в замысел и дизайн исследования; подготовка статьи или ее критический пересмотр в части значимого интеллектуального содержания.

А.В. Зайнутдинова – сбор данных или анализ и интерпретацию данных.

Т.В. Караваева – сбор данных, проведение статистической обработки материалов, анализ и интерпретация данных.

Е.П. Колеватых – проведение микробиологических исследований, анализ и интерпретация данных.

Е.А. Еликов – проведение биохимических исследований, анализ и интерпретация данных.

Е.А. Куклина – критический пересмотр статьи в части значимого интеллектуального содержания.

С.Н. Громова – окончательное одобрение варианта статьи для опубликования.

О.А. Мальцева – окончательное одобрение варианта статьи для опубликования.

В.А. Разумный – окончательное одобрение варианта статьи для опубликования.