DOI: https://doi.org/10.17816/dent121366

Clinical and laboratory substantiation of the effectiveness of professional oral hygiene in preparation for orthopedic treatment with the use of fixed structures of dentures

Alexander V. Lepilin, Natalya B. Zakharova, Maria I. Martynova, Valeriy V. Konnov, Nadezhda L. Erokina

Saratov State Medical University named after V.I. Razumovsky, Saratov, Russia

ABSTRACT

BACKGROUND: To extend the service life of fixed orthopedic structures of dentures, professional oral hygiene (POG) should be conducted before orthopedic treatment based on changes in the cytokine profile in the gingival fluid.

AIM: To assess the nature of changes in the cytokine profile in the gingival fluid during orthopedic treatment with the use of fixed denture structures before and after the POG.

MATERIALS AND METHODS: The patients (*n*=30) were divided into three groups of 10 people each: group 1, patients with intact periodontitis; group 2, patients with mild periodontitis; and group 3, patients with moderate periodontitis. The examination was conducted before the installation of fixed orthopedic structures and before and a week after POG. Six mediators of immunoregulatory processes — interleukin-6 (IL-6), interleukin 1-beta (IL-1ß), tumor necrosis factor alpha (TNF-α), chemokines (IL-8, MCP1), and vascular endothelial growth factor (VEGF) — were quantified in J samples by solid-phase enzyme immunoassay.

RESULTS: In patients with inflammatory periodontal diseases, a high IL-1ß, IL-6, IL-8, MCP1, and VEGF content was found in gingival fluid compared with the group of examined individuals without inflammatory periodontal diseases. After POG, a decrease was found in the content of the main proinflammatory cytokines/chemokines in the blood and the level of VEGF in patients with inflammatory periodontal diseases.

CONCLUSION: A decrease in proinflammatory cytokines, chemokines, and VEGF in gingival fluid after the POG procedure leads to the blockade of inflammatory and destructive processes in periodontal tissues and allows the introduction of personalized practice of preparing supporting teeth in the oral cavity for permanent prosthetics.

Keywords: fixed denture structures; professional oral hygiene; mediators of immunoregulatory processes.

To cite this article:
Lepilin AV, Zakharova NB, Martynova MI, Konnov VV, Erokina NL. Clinical and laboratory substantiation of the effectiveness of professional oral hygiene in preparation for orthopedic treatment with the use of fixed structures of dentures. *Russian Journal of Dentistry.* 2024;28(1):13–19.
DOI: https://doi.org/10.17816/dent121366

Received: 11.01.2023 **Accepted:** 15.10.2023 **Published online:** 15.02.2024

DOI: https://doi.org/10.17816/dent121366

Клинико-лабораторное обоснование эффективности профессиональной гигиены полости рта при подготовке к ортопедическому лечению с применением несъёмных конструкций зубных протезов

А.В. Лепилин, Н.Б. Захарова, М.И. Мартынова, В.В. Коннов, Н.Л. Ерокина

Саратовский государственный медицинский университет имени В.И. Разумовского, Саратов, Россия

АННОТАЦИЯ

Обоснование. Для продления срока службы несъёмных ортопедических конструкций зубных протезов при изменении профиля цитокинов в десневой жидкости необходима профессиональная гигиена полости рта (ПГПР) перед ортопедическим лечением.

Цель исследования — оценить характер изменения профиля цитокинов в десневой жидкости при ортопедическом лечении с применением несъёмных конструкций зубных протезов до и после проведения ПГПР.

Материалы и методы. Обследованы 30 пациентов. Сформированы 3 группы: 1-я группа (*n*=10) — пациенты с интактным пародонтом; 2-я группа (*n*=10) — пациенты с пародонтитом лёгкой степени тяжести; 3-я группа (*n*=10) — пациенты с пародонтитом средней степени. Обследование выполняли до установки несъёмных ортопедических конструкций, до и через неделю после ПГПР. В образцах десневой жидкости методом твёрдофазного иммуноферментного анализа проводили количественное определение шести медиаторов иммунорегуляторных процессов: интерлейкина-6 (IL-6), интерлейкина 1-бета (IL-1β), фактора некроза опухоли альфа (TNF-α); хемокинов (IL-8, MCP1); фактора роста эндотелия сосудов (VEGF).

Результаты. У пациентов с воспалительными заболеваниями пародонта по сравнению с группой обследованных лиц без таких заболеваний в десневой жидкости выявлено высокое содержание IL-1β, IL-6, IL-8, MCP1, а также VEGF. После ПГПР у пациентов с воспалительными заболеваниями пародонта концентрация в десневой жидкости основных провоспалительных цитокинов/хемокинов и VEGF снизилась.

Заключение. Уменьшение концентрации в десневой жидкости провоспалительных цитокинов, хемокинов и VEGF после процедуры ПГПР приводит к блокаде воспалительных и деструктивных процессов в тканях пародонта и позволяет внедрить персонализированную практику подготовки опорных зубов в полости рта к несъёмному протезированию.

Ключевые слова: несъёмные зубные протезы; профессиональная гигиена полости рта; медиаторы иммунорегуляторных процессов.

Как цитировать:

Лепилин А.В., Захарова Н.Б., Мартынова М.И., Коннов В.В., Ерокина Н.Л. Клинико-лабораторное обоснование эффективности профессиональной гигиены полости рта при подготовке к ортопедическому лечению с применением несъёмных конструкций зубных протезов // Российский стоматологический журнал. 2024. Т. 28, № 1. С. 13–19. DOI: https://doi.org/10.17816/dent121366

Рукопись получена: 11.01.2023 **Рукопись одобрена:** 15.10.2023 **Опубликована online:** 15.02.2024

BACKGROUND

Over the years, the emergence of high-performance diagnostics in periodontics has had considerable impact on clinical decision-making, patient outcomes, and the development of new technologies. In practical dentistry, biomarkers such as saliva and oral and gingival fluids released during damage to periodontal tissues indicates the degree of periodontal damage [1, 2].

Cytokines are widely used biomarkers, exhibiting autocrine or paracrine activity in response to local signals and participating in the physiological metabolism of bone tissue and its remodeling [3]. Cytokines are crucial biomarkers in surgical and orthopedic dental treatment [4]. The study of cytokine levels in gingival fluid (GF) reveals the functional activity of the local immune defense system of periodontal tissues during inflammatory processes. This is evidenced by the subsequent suppression of connective tissue resynthesis by fibroblasts and of osteosynthesis and osteo-forming potential.

Currently, fixed dentures supported by natural teeth are the leading traditional method widely used in cases of partial edentulism. However, according to studies by Russian and foreign authors, the average service life of fixed prostheses is 6–10 years. Their loss in the medium or long term is primarily due to the development of carious and/or periodontal lesions of the supporting teeth, increasing their mobility [5]. To prolong the durability of fixed dentures, it is crucial to select the most effective and safe methods and tools for professional oral hygiene (POH) before prosthetic treatment [6], based on the assessment of changes in the cytokine profile in the GF [7]. Thus, improving the effectiveness of prosthetic treatment with fixed dentures is based on a personalized approach to the prevention of inflammation in periodontal tissues using the POH procedures [8–10].

This study aimed to evaluate the character of changes in the cytokine profile in the GF during prosthetic treatment with fixed dentures before and after POH.

MATERIALS AND METHODS

The study included 30 patients with edentulism, plaque, and unsatisfactory oral hygiene indices who required orthodontic treatment with fixed dentures. The examined individuals were aged 20–60 years (average age: 50.0 ± 3.2 years). A general clinical and dental examination was conducted, which included evaluating and identifying oral hygiene indices (papillary–marginal–alveolar index, periodontal index), measuring the depth of periodontal pockets, determining tooth mobility, and assessing gingival bleeding.

Individuals were excluded from the study if they had any of the following contraindications: inflammatory or infectious diseases, a runny nose or respiratory diseases, dental caries or pulpitis, pregnancy or lactation, systemic or endocrine diseases, somatic diseases in a decompensated stage, type 1 or 2 diabetes mellitus, autoimmune or allergic diseases, or tobacco or alcohol abuse.

During preparation for prosthetics, patients were divided into three groups: group 1, 10 individuals with edentulism without clinical manifestations of inflammatory periodontal diseases (with intact periodontium); group 2, 10 individuals with edentulism and clinical manifestations of mild periodontitis; and group 3, 10 patients with moderate periodontitis.

The examination was conducted prior to the installation of fixed orthopedic structures and 1 week following POH. The equipment used were the Piezon Master 400 and AirFlow S1 (EMS, Switzerland).

Before taking the material, the supporting teeth were cleaned of plaque and dried with cotton swabs. Specialized instruments and materials, including paper, endocanal, absorbent pins, and absorbents (taper 0.2 (DENT EVO)), were used for root canal drying during the extraction of GF from the gingival sulcus or periodontal pocket.

Initially, the absorption volume of the obtained liquids per one pin was 5.0 ± 0.05 mg. Two pins were sequentially immersed for 100–120 seconds into the gingival sulcus or periodontal pocket using tweezers and a dental iron, completely impregnated with GF and transferred into an Eppendorf-type tube containing 1,000 µl of 0.155 M sodium chloride solution with 0.2% Pro Clin 300 series biocide. The resulting biomaterial, representing the GF at a dilution of 1:100, was frozen at –40°C and stored until analysis. After thawing and thorough stirring, six mediators of immunoregulatory processes were quantified in diluted samples of GF by solid-phase enzyme-linked immunosorbent assay. The following proinflammatory cytokines were quantified: interleukin (IL)-6, IL-1 beta, and tumor necrosis factor alpha. Additionally, the following chemokines were assessed: IL-8 and monocyte chemoattractant protein 1 (MCP1). Finally, the following vascular endothelial growth factor (VEGF) was evaluated.

The quantitative determination of the concentration of the studied mediators was conducted using commercial reagent kits produced by Vector Best JSC (Novosibirsk, Russia).

The study was approved by the local ethics committee of V.I. Razumovsky Saratov State Medical University (protocol no. 3; dated November 10, 2015). All participants signed informed consent forms for the free transfer of biological material, processing of personal data, examination, and treatment.

Statistical analysis was conducted using the Statistica 10 and SAS JMP11 application program packages. Data were described using the method of nonparametric statistics, specifically the median, 25th, and 75th percentiles. When comparisons were required, the

nonparametric Mann–Whitney and Kruskal–Wallis criteria were employed. p <0.05 indicated statistical significance.

RESULTS

The results of the study showed that patients in groups 2 and 3 (with mild and moderate periodontitis) exhibited similar complaints in preparation for fixed dentures. These patients experienced constant gum bleeding, difficulties in oral hygiene, and occasional pain when eating. Additionally, half of the patients with periodontitis reported pain in the area of separate groups of teeth. The value of the hygiene index in patients with periodontitis increased by approximately 1.5 times compared to that in patients without inflammatory periodontal diseases. The greatest decrease in the papillary–marginal–alveolar index was observed in patients with medium-degree periodontitis. In patients with mild to moderate periodontitis, the content of mediators (proinflammatory cytokines, chemokines, and VEGF) accompanying bone resorption of the alveolar outgrowths of the maxilla or the alveolar part of the mandible significantly increased. In patients with inflammatory periodontal diseases, a high IL-1β, IL-6, IL-8, and MCP1 content was detected in GF compared to those without such diseases. Furthermore, the inflammatory process, accompanied by changes in vascularization and blood flow of periodontal tissues and the development of hypoxia, was accompanied by increased VEGF concentration in GF (Tables 1 and 2).

Elevated proinflammatory cytokines in GF is due to their local expression by periodontal tissues. Increased cytokine and chemokine concentrations promote adhesion and migration of leukocytes and are associated with local production from keratinocytes, monocytes, macrophages, activated T-lymphocytes, endothelial cells, and fibroblasts. That is, in patients with inflammatory periodontal diseases, before the installation of orthopedic constructions of dental prostheses, increased proinflammatory cytokine, chemokine, and VEGF concentrations in GF correspond to an inadequate local immune response to microbial invasion and a decrease in the regenerative activity of periodontal tissues. Consequently, the installation of fixed prosthetic structures results in inflammatory and bone resorptive reactions in the periodontal tissues surrounding the supporting teeth. This, in turn, leads to a shorter service life of fixed dentures.

One week after POH, patients with mild to moderate periodontitis had minimal to no complaints regarding personal oral hygiene difficulties. Objective examination of the oral cavity revealed no evident inflammatory manifestations of periodontitis, and hygiene indices reached values comparable to those of patients with intact periodontium. Following the administration of POH, decreased concentrations of the main proinflammatory cytokines and chemokines and VEGF level were observed in GF. This may be attributed to a decline in the microbial load on periodontal tissues, the inhibition of immunoinflammatory processes, and the enhancement of the recovery processes of supporting periodontal tissues.

DISCUSSION

The high content of immunoregulatory mediators, including proinflammatory cytokines, chemokines, and VEGF, in the environment of cells of the first line of defense of the oral cavity provides a rationale for considering them as biomarkers of oral health disorders. POH procedure was

Table 1. Content of proinflammatory cytokines in the GF before the installation of nonremovable orthopedic structures

Examined groups	IL-1β	TNF-α	IL-6
	Me [25; 75] of gingival fluid, pg/mL		
Intact periodontium:			
Before POH	14,1 [12,6; 16,8]	3,7 [3,0; 5,2]	1,1 [0,9; 1,4]
One week after POH	2,8 [1,5; 3,6]*	1,4 [1,2; 1,8]*	1,6 [1,3; 1,9]
Mild periodontitis:			
Before POH	43,6 [40,8; 49,2]*	13,0 [10,4; 17,5]*	2,9 [2,6; 3,2]*
One week after POH	3,5 [3,1; 4,2]*°	2,1[1,5; 2,3]*°	1,9 [1,4; 2,3]°
Moderate periodontitis:			
Before POH	61,9 [47,3; 85,1]*	13,9 [13,4; 14,5]*	9,8 [8,9; 11,8]*
One week after POH	1,8 [1,4; 2,1]*°	4,1 [2,5; 5,1]°	2,0 [1,5; 2,7]°

Note: PGPR — professional oral hygiene; * statistically significant differences when compared with the group with intact periodontal disease before PGPR; ° — when compared with patients of this group before PGPR (p <0.05).

Table 2. Content of chemokines and VEGF in gingival fluid before the installation of nonremovable orthopedic structures

Examined groups	IL-8	MCP1	VEGF
	Me [25; 75] of gingival fluid, pg/mL		
Intact periodontium:			
Before PGPR	63,2 [55,2; 68,5]	28,2 [25,4; 29,3]	9,4 [8,5; 12,2]
One week after PGPR	7,9 [6,5; 8,3]*	9,7 [8,7; 12,5]*	5,8 [3,6; 6,8]
Mild periodontitis:			
Before PGPR	188,9 [163,9; 201,5]*	172,0 [153,3; 202,8]*	29,6 [27,3; 33,2]*
One week after PGPR	6,0 [4,7; 7,5]*°	11,8 [9,4; 15,3]*°	9,7 [8,1; 13,1]°
Moderate periodontitis:			
Before PGPR	260,3 [235,3; 361,9]*	242,5 [220,2; 248,2]*	36,2 [33,2; 38,6]*
One week after PGPR	5,9 [4,1; 6,3]*°	2,5 [2,1; 3,3]*°	12,3 [7,1; 16,5]°

Note: PGPR — professional oral hygiene; * statistically significant differences when compared with the group with intact periodontal disease before PGPR, ° — when compared with patients of this group before PGPR, p <0.05.

performed prior to fixed dental prostheses placement in almost all patients with intact periodontium and varying degrees of periodontitis. This procedure led to improved oral hygiene indices and a decrease in the activity of the local inflammatory process at the level of the dentogingival junction. One week following POH procedure, a significant decrease was noted in the concentrations of proinflammatory cytokines and chemokines and VEGF in GF. POH resulted in the blockade of inflammatory and bone resorptive processes in periodontal tissues and provided the most effective adaptation of periodontal tissues during the placement of fixed dental prostheses.

CONCLUSIONS

The study of the concentrations of proinflammatory cytokines and chemokines and VEGF in GF during the inflammatory periodontal disease process is crucial in the diagnosis of adverse changes at the level of the immune-epithelial barrier of the oral cavity. The reduction of high concentrations of these biomarkers in GF after POH leads to the blockade of inflammatory and destructive processes in periodontal tissues. This enables the implementation of individualized approaches to the preparation of supporting teeth for prosthetic treatment, particularly in fixed dental prostheses.

ADDITIONAL INFORMATION

Funding source. This study was not supported by any external sources of funding.

Competing interests. The authors declare that they have no competing interests.

Authors' contribution. All authors confirm that their authorship meets the international ICMJE criteria (all authors made a significant contribution to the development of the concept, conduct of the study and preparation of the article, read and approved the final version before publication).

The largest contribution is distributed as follows: A.V. Lepilin, N.B. Zakharova, M.I. Martynova — conducting research, creating a concept, writing the text; V.V. Konnov — literature review, text writing; N.L. Erokina — statistical data processing, article design.

REFERENCES

1. Bergamo AZN, Nelson-Filho P, do Nascimento C, et al. Cytokine profile changes in gingival crevicular fluid after placement different brackets types. *Arch Oral Biol*. 2018;85:79–83. doi: 10.1016/j.archoralbio.2017.09.022

2. de Aguiar MC, Perinetti G, Capelli J Jr. The gingival crevicular fluid as a source of biomarkers to enhance efficiency of orthodontic and functional treatment of growing patients. *Biomed Res Int*. 2017;2017:3257235. doi: 10.1155/2017/3257235

3. Baeshen HA. Assessment of salivary pro inflammatory cytokines profile level in patients treated with labial and lingual fixed orthodontic appliances. *PLoS One*. 2021;16(4):e0249999. doi: 10.1371/journal.pone.0249999

4. Kapoor P, Kharbanda OP, Monga N, et al. Effect of orthodontic forces on cytokine and receptor levels in gingival crevicular fluid: a systematic review. *Prog Orthod*. 2014;15(1):65. doi: 10.1186/s40510-014-0065-6

5. Veizaj I, Gvozdikova EN. Improving the effectiveness of conservative treatment of inflammatory periodontal diseases due to the optimization of the methods of professional oral hygiene. *The Journal of Scientific Articles Health and Education Millennium*. 2015;17(2):43–45. EDN: TOODWH

6. Zakharova NB, Lepilin AV, Vorobjev DV, et al. The use of professional oral hygiene in orthodontic treatment on the results of studies of gingival fluid biomarkers. *Saratov Journal of Medical Scientific Research*. 2015;11(2):168–173. EDN: WVNBBV

7. Virabyan VA, Kolesova T.V. Changes in immunologic indices in the process of adaptation to fixed orthopedic constructions. *Sovremennye tendencii razvitija nauki i tehnologij*. 2015;(5-1):94–96. EDN: UHWLIL

8. Lepilin AV, Ostrovskaya LYu, Zakharova NB, Erokina NL. *Modern technologies and rationale of pathogenetic treatment of periodontal diseases.* Saratov: Saratovskij gosudarstvennyj medicinskij universitet imeni V.I. Razumovskogo; 2014. 138 p. EDN: XWOUZV

9. Erokina NL, Lepilin AV, Mironov AYu. The role of cytokines, chemokines and growth factors in extraction socket healing. *Parodontologiya*. 2021;26(1):58–63. EDN: XWTMAN doi: 10.33925/1683-3759-2021-26-1-58-63

10. Ostrovskaya LYu, Eremin OV, Zakharova NB, et al. Gum fluid biomarkers in personalized diagnostics of inflammatory periodontal diseases. *Archiv EuroMedica*. 2021;11(4):130–135. doi: 10.35630/2199-885X/2021/11/4.30

СПИСОК ЛИТЕРАТУРЫ

1. Bergamo A.Z.N., Nelson-Filho P., do Nascimento C., et al. Cytokine profile changes in gingival crevicular fluid after placement different brackets types // Arch Oral Biol. 2018. Vol. 85. P. 79–83. doi: 10.1016/j.archoralbio.2017.09.022

2. de Aguiar M.C., Perinetti G., Capelli J. Jr. The gingival crevicular fluid as a source of biomarkers to enhance efficiency of orthodontic and functional treatment of growing patients // Biomed Res Int. 2017. Vol. 2017. P. 3257235. doi: 10.1155/2017/3257235

3. Baeshen H.A. Assessment of salivary pro inflammatory cytokines profile level in patients treated with labial and lingual fixed orthodontic appliances // PLoS One. 2021. Vol. 16, N 4. P. e0249999. doi: 10.1371/journal.pone.0249999

4. 4. Kapoor P., Kharbanda O.P., Monga N., et al. Effect of orthodontic forces on cytokine and receptor levels in gingival crevicular fluid: a systematic review // Prog Orthod. 2014. Vol. 15, N 1. P. 65. doi: 10.1186/s40510-014-0065-6

5. Веизай И., Гвоздикова Е.Н. Повышение эффективности консервативного лечения воспалительных заболеваний пародонта за счет оптимизации методов профессиональной гигиены полости рта // Журнал научных статей Здоровье и образование в XXI веке. 2015. Т. 17, № 2. С. 43–45. EDN: TOODWH

6. Захарова Н.Б., Лепилин А.В., Воробьев Д.В., и др. Обоснование применения профессиональной гигиены полости рта при ортодонтическом лечении по результатам исследования биомаркеров десневой жидкости // Саратовский научно-медицинский журнал. 2015. Т. 11, № 2. С. 168–173. EDN: WVNBBV

7. 7. Вирабян В.А., Колесова Т.В. Изменение иммунологических показателей в процессе адаптации к несъемным ортопедическим конструкциям // Современные тенденции развития науки и технологий. 2015. № 5-1. С. 94–96. EDN: UHWLIL

8. Лепилин А.В., Островская Л.Ю., Захарова Н.Б., Ерокина Н.Л. Современные технологии и обоснование патогенетического лечения заболеваний пародонта. Саратов: Саратовский государственный медицинский университет имени В.И. Разумовского, 2014. 138 с. EDN: XWOUZV

9. Ерокина Н.Л., Лепилин А.В., Миронов А.Ю., и др. Роль цитокинов, хемокинов и факторов роста в заживлении лунок удаленных зубов // Пародонтология. 2021. Т. 26, № 1. С. 58–63. EDN: XWTMAN doi: 10.33925/1683-3759-2021-26-1-58-63

10. Ostrovskaya L.Yu., Eremin O.V., Zakharova N.B., et al. Gum fluid biomarkers in personalized diagnostics of inflammatory periodontal diseases // Archiv EuroMedica. 2021. Vol. 11, N 4. P. 130–135. doi: 10.35630/2199-885X/2021/11/4.30

AUTHORS' INFO

*** Natalya B. Zakharova,** MD, Dr. Sci. (Medicine), Professor;
address: 112 Bol'shaja Kazach'ja street, 410012 Saratov, Russia;
ORCID: 0000-0001-9410-2240;
eLibrary SPIN: 5354-6327;
e-mail: lipidgormon@mail.ru

Alexander V. Lepilin, MD, Dr. Sci. (Medicine), Professor;
ORCID: 0000-0001-6940-5178;
eLibrary SPIN: 4293-9439;
e-mail: lepilins@mail.ru

Maria I. Martynova;
ORCID: 0000-0003-3036-3534;
e-mail: gaichka8@rambler.ru

Valeriy V. Konnov, MD, Dr. Sci. (Medicine), Professor;
ORCID: 0000-0002-5457-3926;
eLibrary SPIN: 9467-5421;
e-mail: konnovvaleriy@rambler.ru

Nadezhda L. Erokina, MD, Dr. Sci. (Medicine), Associate Professor;
ORCID: 0000-0001-9189-4422;
eLibrary SPIN: 2222-8837;
e-mail: nadleo@mail.ru

* Corresponding author / Автор, ответственный за переписку

ОБ АВТОРАХ

*** Захарова Наталия Борисовна,** д-р мед. наук, профессор;
адрес: Россия, 410012, Саратов, ул. Большая Казачья, д. 112;
ORCID: 0000-0001-9410-2240;
eLibrary SPIN: 5354-6327;
e-mail: lipidgormon@mail.ru

Лепилин Александр Викторович, д-р мед. наук, профессор;
ORCID: 0000-0001-6940-5178;
eLibrary SPIN: 4293-9439;
e-mail: lepilins@mail.ru

Мартынова Мария Игоревна;
ORCID: 0000-0003-3036-3534;
e-mail: gaichka8@rambler.ru

Коннов Валерий Владимирович, д-р мед. наук, профессор;
ORCID: 0000-0002-5457-3926;
eLibrary SPIN: 9467-5421;
e-mail: konnovvaleriy@rambler.ru

Ерокина Надежда Леонидовна, д-р мед. наук, доцент;
ORCID: 0000-0001-9189-4422;
eLibrary SPIN: 2222-8837;
e-mail: nadleo@mail.ru