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IMPROVING THE EFFECTIVENESS OF PHYSIOLOGICAL ADAPTATION OF PATIENTS TO COMPLETE REMOVABLE DENTURES USING ELECTROMYOGRAPHIC BIOFEEDBACK

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Abstract. ***Introduction.*** Complete absence of teeth is a very common pathology, especially in the elderly, and removable dentures are mainly used for its treatment. Various local and general mechanisms are used to reduce the process of adaptation to dentures in patients with complete absence of teeth. We suggest using the principle of biofeedback, which is safe, does not require medical support, and optimizes the adaptation process by activating the human body's own reserves, through active patient involvement and conscious training of the musculoskeletal system. ***The aim of the study*** is to optimize the adaptation process of primary prosthetic patients with complete removable plate prostheses using the principle of biofeedback. ***Materials and methods.*** The research was aimed at substantiating the effectiveness of the biofeedback method to optimize the adaptation of patients to removable dentures after complete tooth loss. The study involved 50 elderly people (60–74 years old). All patients were treated for complete absence of teeth with removable dentures, but the patients of the main group received biofeedback therapy at the treatment stages to optimize adaptation. ***Results.*** When comparing the results of the group receiving traditional treatment and the group using correction with biofeedback, it was found that the adaptation to full removable plate prostheses occurred faster in the second group. According to electromyography and gnathodynamometry data, patients receiving biofeedback therapy at the treatment stages had already adapted to full removable plate prostheses on day 14. We have proved the effectiveness of the implementation of the proposed technology to optimize the process of adaptation to removable dentures. ***Conclusion.*** Based on the results of objective physiological and subjective studies, it can be seen that the use of the author's algorithm based on the principles of biofeedback makes it possible to shorten the period of adaptation of patients to complete removable plate prostheses, thereby optimizing the process of getting used to complete removable orthopedic structures.

Keywords: electromyographic biofeedback, complete absence of teeth, physiological adaptation to removable plate prostheses

ПОВЫШЕНИЕ ЭФФЕКТИВНОСТИ ФИЗИОЛОГИЧЕСКОЙ АДАПТАЦИИ ПАЦИЕНТОВ К ПОЛНЫМ СЪЕМНЫМ ЗУБНЫМ ПРОТЕЗАМ С ИСПОЛЬЗОВАНИЕМ ЭЛЕКТРОМИОГРАФИЧЕСКОЙ БИОЛОГИЧЕСКОЙ ОБРАТНОЙ СВЯЗИ

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Резюме. ***Введение.*** Полное отсутствие зубов является весьма распространенной патологией, особенно у пожилых людей, для ее лечения в основном применяют съемные пластиночные протезы. Для сокращения процесса адаптации к протезам у пациентов с полным отсутствием зубов используют различные локальные и общие механизмы. Мы же предлагаем использовать принцип биологической обратной связи (БОС), который безопасен, не требует медикаментозной поддержки, оптимизирует процесс адаптации за счет активизации собственных резервов организма человека путем активного вовлечения пациента и осознанной тренировки мышечного звена зубочелюстной системы. ***Цель исследования*** — оптимизация процесса адаптации первично протезируемых пациентов полными съемными пластиночными протезами с использованием принципа БОС. ***Материалы и методы.*** Исследования были направлены на обоснование эффективности применения метода БОС для оптимизации адаптации пациентов к съемным пластиночным протезам после полной потери зубов. В исследовании приняли участие 50 человек пожилого возраста (60–74 года). Всем пациентам было проведено лечение полного отсутствия зубов съемными пластиночными протезами, но пациенты основной группы на этапах лечения для оптимизации адаптации получали терапию с БОС. ***Результаты.*** При сравнении результатов группы, получающей традиционное лечение, и группы, использующей коррекцию с БОС, установлено, что у второй группы адаптация к полным съемным пластиночным протезам наступила быстрее. У пациентов, получающих БОС-терапию, на этапах лечения уже на 14-й день по данным электромиографии и гнатодинамометрии наступила адаптация к полным съемным пластиночным протезам. Нами доказана эффективность внедрения предложенной технологии оптимизации процесса адаптации к съемным зубным протезам. ***Заключение.*** По результатам объективных физиологических и субъективных исследований видно, что применение авторского алгоритма, основанного на принципах БОС, позволяет сократить период адаптации пациентов к полным съемным пластиночным протезам и тем самым оптимизировать процесс привыкания к полным съемным ортопедическим конструкциям.

Ключевые слова: электромиографическая биологическая обратная связь, полное отсутствие зубов, физиологическая адаптация к съемным пластиночным протезам

INTRODUCTION

Restoration of chewing function, dental aesthetics and quality speech in the complete absence of teeth is one of the urgent tasks of modern dentistry. Removable dentures are mainly used to treat the complete absence of teeth. Adaptation to removable dentures is different for each individual patient, and often even a correctly manufactured denture with good fixation does not guarantee rapid adaptation [1–4]. The process of adaptation to removable dentures is influenced by many factors: atrophy of the alveolar process, physiological characteristics of the patient's body as a whole, and psychological characteristics of each individual patient [5–7]. Various local and general mechanisms are used to reduce the adaptation time to removable dentures in patients with a complete absence of teeth. A significant share of the influence is exerted by topical medications. A number of authors recommend using various adhesive agents, modified adhesive compositions [8–10]. Foreign literature describes digital technologies for the manufacture of complete removable dentures, which improve their quality and accelerate the process of getting used to them [11, 12].

When choosing a method for optimizing patient adaptation to complete removable dentures, we proceeded from the fact that the principle of biofeedback is safe. It also does not require medication support, optimizes the adaptation process by activating the human body's own reserves through active patient involvement and conscious training of muscles of the stomatognathic system [13–15]. Thus, it seems relevant to use biofeedback to optimize adaptation to complete removable dentures.

AIM

The aim of the study is to optimize the adaptation process of primary prosthetic patients with complete removable dentures using the principle of biofeedback.

MATERIALS AND METHODS

Two groups of individuals were surveyed to determine the effectiveness of the approach we developed to optimize the adaptation process. The 1st group (control group) received traditional treatment, while the 2nd group (main group) received biofeedback therapy. Each group included 25 patients.

In accordance with the Standards of Medical Care, the condition of all patients met the following criteria and signs: complete absence of teeth on one or both jaws; absence of sharp bone prominences (exostoses); absence of pronounced atrophy of the alveolar process (with complete absence of teeth on one or both jaws). Complete absence of teeth on the upper jaw with a high alveolar process of the upper jaw, uniformly lined with dense mucosa, with well-defined maxillary tuberosity, deep palate, poorly expressed torus or its absence allowed to classify patients as type I according to the Schroeder classification. Complete absence of teeth on the lower jaw with a pronounced alveolar ridge, when the transitional fold is located far its crest, allowed to classify patients as type I according to the Keller classification. Healthy oral mucosa is moderately flexible, moderately mobile, pale pink, well-moistened. This allowed us to classify patients as I class according to the Supple classification. In addition, the patients did not have pathology of the temporomandibular joint and masticatory muscles.

The patient's adaptation correction was carried out for 10 days. It included: author's complex of myogymnastic exercises (invention patent RU 2812832 C1 dated 02.02.2024), author's method of training patients with complete absence of teeth using the principles of biofeedback (invention patent RU 2802148 C1 dated 22.08.2023), author's training plastic base with a plastic roller (utility model patent RU 202617 U1 dated 01.03.2021). Myogymnastics was carried out taking into account the individual physiological characteristics of the maxillofacial area of patients and using a plastic roller with a plastic base specially developed by us (utility model patent RU 213341 U1 dated 07.09.2022) [16–18].

Medical check-up of patients at the stages of treatment included: dental check-up of the maxillofacial area and the

Table 1

Results of the assessment of patient adaptation at the stages of treatment with the traditional method and using correction with biological feedback according to gnathodynamometry data (M±m)

Таблица 1

Результаты оценки адаптации пациентов на этапах лечения традиционным методом и с использованием коррекции с биологической обратной связью по данным гнатодинамометрии (M±m)

Срок наблюдения / Observation period	Контрольная группа, с традиционным лечением / Control group, with conventional treatment (n=25)		Основная группа, с использованием БОС-терапии на этапах лечения / The main group, using biofeedback therapy at the stages of treatment (n=25)		t-критерий Стьюдента / Student's t-test	P
	сила сокращения жевательных мышц, Н / force of contraction of masticatory muscles, N					
	сторона / side		сторона / side			
	правая / right	левая / left	правая / right	левая / left		
Первое посещение / First visit	90,5±2,6	93,6±2,5	90,5±2,6	93,6±2,5	0,27	0,8
Шестое посещение / Sixth visit	91,0±2,3	93,6±3,3	92,0±2,3	94,5±2,3	0,61	0,5
3 дня после наложения протеза / 3 days after the prosthesis is applied	90,4±2,5	95,3±2,1	98,3±2,5	97,3±2,1	2,7	0,00005*
7 дней после наложения протеза / 7 days after the prosthesis is applied	100,4±1,5	105,3±2,2	115,4±2,5	116,3±2,1	4,18	0,000064*
14 дней после наложения протеза / 14 days after the prosthesis is applied	110,1±2,1	111,5±1,6	125,1±4,1	125,5±3,6	3,9	0,00017*
30 дней после наложения протеза / 30 days after the prosthesis is applied	130,1±4,3	131,1±3,2	139,1±2,3	139,1±2,2	2,35	0,02*
60 дней после наложения протеза / 60 days after prosthesis placement	135,5±6,3	134,1±4,1	140,1±4,1	139,6±6,3	0,5	0,6

* Differences in the same indicators between groups are statistically significant (p <0.05).
* Различия одноименных показателей между группами статистически достоверны (p <0,05).

oral cavity itself, palpation, gnathodynamometry (GDM), electromyography (EMG), autonomic nervous system (ANS) testing, modified technique for assessing adaptation to orthopedic dental structures "AOS", OHIP-14-Ru questionnaire for assessing the quality of life, and maladjustment coefficient (MC).

Statistical analysis of the data was performed using the STATISTICA 7.0 software package. The normality of distribution was assessed using the Kolmogorov-Smirnov test followed by the parametric method. Differences were considered significant at $p \leq 0.05$.

RESULTS

The vegetative Kerdo index (KI) values in patients of both clinical groups before the start of treatment did not differ significantly (mean value was 10.0), which was additional evidence of the similarity of these clinical groups. On the first day after insertion of a complete removable denture, an increase in heart rate (HR) and, accordingly, KI (sympathicotonia) from 60.5 to 65.8% was recorded in both study groups. On the seventh day after insertion of a denture, the HR and KI values in the main group approached normal values, and in the control group, sympathicotonia was observed, which is characteristic of a stress state ($p < 0.05$ with the first group). During control visits after 30 and 60 days of treatment, patients in both clinical groups had KI values within normal limits.

The gnathodynamometry values in patients of both groups before the start of treatment did not differ significantly (mean value was 92N), which was additional evidence of the similarity of these groups (Table 1).

On the first day after denture insertion, a slight increase in the chewing force from 1.5 to 1.8% was recorded in both clinical groups, both on the functionally dominant and non-dominant chewing sides. On the 7th and 14th days after insertion of a complete removable denture, the pressure force was partially restored, but when using the traditional approach, it was only 102.4±7.7 N. At the same time, in patients of the second

Table 2

Results of the assessment of patient adaptation at the stages of treatment with the traditional method and using correction with biofeedback according to electromyography data of the masticatory muscles (M±m)

Таблица 2

Результаты оценки адаптации пациентов на этапах лечения традиционным методом и с использованием коррекции с биологической обратной связью по данным электромиографии жевательных мышц (M±m)

Срок наблюдения / Observation period	Контрольная группа, с традиционным лечением / Control group, with conventional treatment (n=25)		Основная группа, с использованием БОС-терапии на этапах лечения / The main group, using biofeedback therapy at the stages of treatment (n=25)		t-критерий Стью-дента / Student's t-test	P
	электромиография, мкВ / electromyography, μV					
	сторона		сторона			
	правая	левая	правая	левая		
Первое посещение / First visit	52,0±6,1	41,0±6,5	53,0±5,2	42,0±5,1	0,12	0,9
Шестое посещение / Sixth visit	150,1±6,5	120,0±5,4	140,0±7,6	100,0±5,5	1,04	0,3
3 дня после наложения протеза / 3 days after the prosthesis is applied	160,5±5,5	120,0±4,5	100,9±5,7	70,0±4,6	7,57	0,00001*
7 дней после наложения протеза / 7 days after the prosthesis is applied	130,2±4,4	100,0±5,3	70,1±3, 5	60,8±5,6	9,53	0,000001*
14 дней после наложения протеза / 14 days after the prosthesis is applied	110,0±5,5	80,1±4,4	55,3±3,6	50,4±4,5	7,74	0,000001*
30 дней после наложения протеза / 30 days after the prosthesis is applied	53,3±3,6	50,2±3,4	52,5±2,6	50,4±2,1	2,23	0,8
60 дней после наложения протеза / 60 days after prosthesis placement	50,6±0,7	50,2±0,8	50,1±0,4	50,8±0,6	0,62	0,54

* Различия одноименных показателей между группами статистически достоверны ($p < 0,05$).

* Differences in the same indicators between groups are statistically significant ($p < 0.05$).

group it was 115.3±8.9 N ($p < 0.05$ with the first group). During control visits after 30 and 60 days of treatment, the GDM values were recorded in patients of both clinical groups within the normal limits. However, during treatment using the principle of biofeedback, the values of the force of chewing pressure of the muscles were higher than in the first group.

The bioelectrical activity (BEA) of the studied muscles was examined using the method of total electromyography (Table 2). Standard wireless sensors were used, which were placed along the course of muscle fibers on the right and left above the motor point of the masseter muscle.

As a result of assessing the EMG parameters in the control group, at maximum muscle stress, a high-frequency curve was recorded with average amplitude of 52.0±6.1 μV on the right, and 41.0±6.5 μV on the left before prosthetics of the masseter muscle itself. Meanwhile, in the main group, values were 53.0±5.2 μV on the right side, and 42.0±5.1 μV on the left. Bioelectrical activity in men and women differed slightly, and therefore the electromyography data of men and women were considered together.

The next day after insertion of a removable denture (6th visit), according to the results of the EMG: in the control group, at maximum muscle stress, a high-frequency curve was recorded with amplitude of contraction of the masticatory muscle itself of 150.1±6.5 μV on the right side, and 120.0±5.4 μV on the left. At the same time, in the main group, values were 140.0±7.6 μV on the right side, and 100.0±5.5 μV on the left. It is seen that in patients of the main and control groups there was a "jump" in the bioelectrical activity of the masticatory muscles immediately after insertion of a removable denture, since it is a strong irritant.

On the third day after insertion of a removable denture in the control group, at maximum muscle stress, a high-frequency curve was recorded on the EMG of the masticatory muscle itself with average amplitude of 160.5 ± 5.5 μV on the right side, and 120.0 ± 4.5 μV on the left before prosthetics. Meanwhile, in the main group, values were 100.9 ± 5.7 μV on the right side, and 70.0 ± 4.6 μV on the left. It is evident that in patients of the main and control groups of the study, according to the bioelectrical activity of the masticatory muscles of the right and left sides, signs of asymmetry of the indicators are preserved.

On the seventh day after insertion of a removable denture in the control group, at maximum muscle stress, a high-frequency curve was recorded on the EMG with average amplitude of 130.2±4.4 μV on the right side, and 100.0±5.3 μV on the left before prosthetics of the masticatory muscle itself. At the same time, in the main group, values were 70.1±3.5 μV on the right side, and 60.8±5.6 μV on the left. It is seen that in patients of the main group, the bioelectrical activity of the masticatory muscles of the right and left sides approached the initial values. Also, the indicators on the right and left are almost the same (which indicates a good prognosis for adaptation), while this is not observed in patients in the control group.

On the fourteenth day after insertion of a removable denture in the control group, at maximum muscle stress, a high-frequency curve was recorded on the EMG with average amplitude of 110.0±5.5 μV on the right side, and 80.1±4.4 μV on the left before prosthetics of the masticatory muscle itself. Meanwhile, in the main group, values were 55.3±3.6 μV on the right side, and 50.4±4.5 μV on the left. It is evident that in patients of the main group, the bioelectrical activity of the masticatory muscles of the right and left sides approached the initial values. Also, the indicators on the right and left are almost the same (which indicates the onset of adaptation in the main group), while this is not observed in patients in the control group.

On the thirtieth day after insertion of a removable denture in the control group, at maximum muscle stress, a high-frequency curve was recorded on the EMG with average amplitude of 53.3±3.6 μV on the right side, and 50.2±3.4 μV on the left before prosthetics of the masticatory muscle itself. At the same time, in the main group, values were 52.5±2.6 μV on the right side, and 50.4±2.1 μV on the left. The masticatory muscles of the subjects in both groups work symmetrically, which is confirmed by the symmetry of their strength indicators and can be considered a sign of successful adaptation.

On the sixtieth day after insertion of a removable denture, a high-frequency curve was recorded on the EMG in the control group at maximum muscle stress with average amplitude of 50.6±0.7 μV on the right side, and 50.2±0.8 μV on the left before the prosthesis the masticatory muscle itself. Meanwhile, in the main group, the EMG values were 50.1±0.4 μV on the right side, and 50.8±0.6 μV on the left. In patients of the main and control groups, the bioelectrical activity of the masticatory muscles of the right and left sides is almost the same. The masticatory muscles of the subjects in both groups work symmetrically, which is confirmed by the symmetry of their strength indicators and can be considered a sign of successful adaptation.

When analyzing the data of the assessment of patients in both groups after insertion of removable dentures using the "Maladjustment Scale" (MC — maladjustment coefficient), it is shown that on the day of denture insertion in the first (control) group, MC was equal to an average of 122.4±0.3. In the second group MC was 107.2±0.3. During medical check-up of patients on the 7–14th day after insertion of removable dentures in the first (control group) and second (main group, patients received biofeedback therapy) groups, the MC was 110±6.2 and 48.0±4.3, respectively. This indicates a relatively more favorable course of the adaptation process in patients in the case of using the myogymnastic complex with biofeedback in treatment. Medical check-up of patients on the 30th–60th day after denture insertion revealed a further decrease in

KDA values to 6.3±0.4 in the main group and to 4.1±0.3 in the comparison group. It should be noted that adaptation is considered to have occurred already at values of KDA less than 10. Thus, it is obvious that patients of the main group have a higher degree of adaptation to removable dentures ($p < 0.05$).

Before treatment, the OHIP-14-Ru questionnaire scores (the "Quality of Life Questionnaire") were higher than 56 points in both groups and amounted to 65±7.4. Immediately after denture insertion, the OHIP-14-Ru questionnaire scores in the first (main) group were slightly higher than 56 points and amounted to 57±5.7 points. In the second group (comparison group), the scores were 55±5.4 points, indicating a satisfactory level of quality of life ($p < 0.001$).

According to the data of electromyography and gnathodynamometry of the masticatory muscles, adaptation in patients of the main group occurred on the 14th day after denture insertion, and in patients of the control group — only on the 30th day after fixation of the complete removable denture.

Thus, the application of biofeedback at the stages of treatment of patients with a complete absence of teeth using removable dentures reduces the level of maladaptive impact of dental manipulations on chewing function. In addition, this approach ensures more complete and accelerated restoration of the main physiological characteristics of masticatory muscles of stomatognathic system.

CONCLUSION

Based on the results of objective physiological and subjective studies, it can be seen that using the author's algorithm based on principles of biofeedback makes it possible to shorten the period of adaptation of patients to complete removable dentures, thereby optimizing the process of getting used to complete removable orthopedic structures.

The tactics we have developed for managing patients with complete absence of teeth include a complex of myogymnastic exercises, method for training patients with complete absence of teeth using principles of biofeedback, as well as the use of technical devices we have proposed (a training plastic base with a plastic roller). This tactic allows us to optimize the process of adaptation to removable dentures. Therefore, it is advisable to include it in the protocol for dental treatment of patients with complete absence of teeth.

ADDITIONAL INFORMATION

Author contribution. Thereby, all authors made a substantial contribution to the conception of the study, acquisition, analysis, interpretation of data for the work, drafting and revising the article, final approval of the version to be published and agree to be accountable for all aspects of the study.

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Данная публикация является частью диссертационного исследования на соискание степени кандидата медицинских наук Ольги Сергеевны Чепуряевой.

Конфликт интересов. Авторы декларируют отсутствие явных и потенциальных конфликтов интересов, связанных с публикацией настоящей статьи.

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REFERENCES

1. Iordanishvili A.K., Veretenko Ye.A., Serikov A.A., Lobeyko V.V., Balin D.V. Complete loss of teeth in an adult: age-related features of prevalence, need for treatment and clinical picture. Kurskiy nauchno-prakticheskiy vestnik Chelovek i yego zdorov'ye. 2015;1:23–32. (In Russian).
2. Bibarsova M.I., Konnov V.V. Expiration of the adaptation period to complete removable plate dentures is a reason for the beginning of slowing down of jaw atrophy. Materialy XXXIX Mezhdunarodnoy nauchno-prakticheskoy konferentsii. Moscow; 2018:218–219. (In Russian).
3. Joanna K., Teresa S., Maria G.J. Evaluation of functional parameters in the occlusion of complete denturewearers before and after prosthetic treatment. Prosthodont Res. 2017;61(4):480–490.
4. Samarina Ya.P. Secondary dental adentia: consequences and methods of treatment. Nauchnoye obozreniye. Meditsinskiye nauki. 2017;3:71–74. Available at: https://science-medicine.ru/ru/article/view?id=1000 (accessed: 03/14/2022). (In Russian).
5. Mal'neva K.Ye., Yachmeneva L.A. Adaptation to removable plate prostheses with complete adentia. V sbornike: Sovremennyye problemy nauki i obrazovaniya. Materialy XI Mezhdunarodnoy studencheskoy nauchnoy konferentsii. 2019:59–60. (In Russian).
6. Kamalakidis S.N., Anastassiadou V., Sofou A., Pissiotis A.L. Comparative Study of Acceptance and Adaptation to New Complete Dentures, Using Two Construction Protocols. J Prosthodont. 2016;25(7):536–543.

7. Kiprin D.V., Samotosov P.A., Ibragimov T.I., Bondar' S.A., Yur'yev V.A. Manufacture of a plastic plate denture for the restoration of jaw adentia. Sibirskoye meditsinskoye obozreniye. 2012;4(76):30–32. (In Russian).
8. Meriem Amine et al. Needs and Demands in Prosthetic Treatment in the Population Followed within the Prosthetic Department of Casablanca's Dental Consultation and Treatment Center. Int J Dentistry Oral Sci. 2016;3(2):200–204.
9. Suzuki H., Kanazawa M., Komagamine Y. et al. Influence of simplified dietary advice combined with new complete denturefabrication on masticatory function of complete denture wearers. J Oral Rehabil. 2019;46(12):1100–1106.
10. Woda A., Foster K., Mishellany A., Peyron M.A. et al. Adaptation of healthy mastication to factors pertaining to the individual or to the food. Physiol Behav. 2006;89(1):28–35.
11. Giggins O.M. Persson U.M., Caulfield B.J. Biofeedback in rehabilitation. Neuroeng Rehabil. 2013;10:60.
12. Prishchepa A.V., Danilov A.B. The effectiveness of the biofeedback method connections in the treatment of chronic tension headache and chronic migraine. Meditsinskiy alfavit. 2018;2(17):19–25. (In Russian).
13. Cheynet F. TMJ, eating and breathing. Rev Stomatol Chir Maxillofac Chir Orale. 2016;117(4):199–206.
14. Shemonaev V.I., Mashkov A.V., Maloletkova A.A., Klaucek S.V. The role of gnathotraining in the adaptation of patients to dental orthopedic treatment. Volgogradskiy nauchno-meditsinskiy zhurnal. 2014;1(41):53–55. (In Russian).
15. Chepuryaeva O.S., Klaucek S.V., Shemonaev V.I., Danilina T.F., Mikhalchenko D.V., Shkarin V.V. Plastic base with a plastic roller for the lower jaw. Patent na poleznuyu model' RU 202617 U1, 01.03.2021. Zayavka No. 2020117312/14(028971). (In Russian).
16. Chepuryayeva O.S., Klauchek S.V., Shemonayev V.I., Danilina T.F., Mikhal'chenko D.V., Shkarin V.V. Plastic roller with a plastic base for the upper jaw. Patent na poleznuyu model' RU 213341 U1, 07.09.2022. Zayavka No. 2021130950. (In Russian).
17. Chepuryayeva O.S., Klauchek S.V., Shemonayev V.I., Pozdnyakov A.M. Complex of myogymnastic exercises for training and normalization of the work of the masticatory muscles of patients with complete absence of teeth. Patent na izobreteniye RU 2812832 C1, 02.02.2024. Zayavka ot 03.22.2023. (In Russian).
18. Chepuryaeva O.S. A method for training the chewing muscles of patients with complete absence of teeth using the principles of biofeedback. Patent na izobreteniye RU 2811761 C1, 16.01.2024. Zayavka ot 06.02.2023. (In Russian).

ЛИТЕРАТУРА

1. Иорданишвили А.К., Веретенко Е.А., Сериков А.А., Лобейко В.В., Балин Д.В. Полная утрата зубов у взрослого человека: возрастные особенности распространенности, нуждаемости в лечении и клинической картины. Курский научно-практический вестник Человек и его здоровье. 2015;1:23–32.
2. Бибарсова М.И., Коннов В.В. Истечение периода адаптации к полным съемным пластиночным протезам — повод к началу замедления атрофии челюстей. Материалы XXXIX Международной научно-практической конференции. М.; 2018: 218–219.
3. Joanna K., Teresa S., Maria G.J. Evaluation of functional parameters in the occlusion of complete denturewearers before and after prosthetic treatment. Prosthodont Res. 2017;61(4):480–490.
4. Самарина Я.П. Вторичная адентия зубов: последствия и способы лечения. Научное обозрение. Медицинские науки. 2017;3:71–74. Доступно по: https://science-medicine.ru/ru/article/view?id=1000 (дата обращения: 14.03.2022).
5. Мальнева К.Е., Ячменева Л.А. Адаптация к съемным пластиночным протезам при полной адентии. В сборнике: Современные проблемы науки и образования. Материалы XI Международной студенческой научной конференции. 2019:59–60.
6. Kamalakidis S.N., Anastassiadou V., Sofou A., Pissiotis A.L. Comparative Study of Acceptance and Adaptation to New Complete Dentures, Using Two Construction Protocols. J Prosthodont. 2016;25(7):536–543.
7. Киприн Д.В., Самотёсов П.А., Ибрагимов Т.И., Бондарь С.А., Юрьев В.А. Изготовление пластмассового пластиночного зубного протеза для восстановления адентии челюстей. Сибирское медицинское обозрение. 2012;4(76):30–32.
8. Meriem Amine et al. Needs and Demands in Prosthetic Treatment in the Population Followed within the Prosthetic Department of Casablanca's Dental Consultation and Treatment Center. Int J Dentistry Oral Sci. 2016;3(2):200–204.
9. Suzuki H., Kanazawa M., Komagamine Y. et al. Influence of simplified dietary advice combined with new complete denturefabrication on masticatory function of complete denture wearers. J Oral Rehabil. 2019;46(12):1100–1106.
10. Woda A., Foster K., Mishellany A., Peyron M.A. et al. Adaptation of healthy mastication to factors pertaining to the individual or to the food. Physiol Behav. 2006;89(1):28–35.
11. Giggins O.M. Persson U.M., Caulfield B.J. Biofeedback in rehabilitation. Neuroeng Rehabil. 2013;10:60.
12. Прищепа А.В., Данилов А.Б. Эффективность метода биологической обратной связи в лечении хронической головной боли напряжения и хронической мигрени. Медицинский алфавит. 2018;2(17):19–25.
13. Cheynet F. TMJ, eating and breathing. Rev Stomatol Chir Maxillofac Chir Orale. 2016;117(4):199–206.
14. Шемонаев В.И., Машков А.В., Малолеткова А.А., Клаучек С.В. Роль гнатотренинга в адаптации пациентов к стоматологическому ортопедическому лечению. Волгоградский научно-медицинский журнал. 2014;1(41):53–55.
15. Чепуряева О.С., Клаучек С.В., Шемонаев В.И., Данилина Т.Ф., Михальченко Д.В., Шкарин В.В. Пластмассовый базис с пластмассовым валиком на нижнюю челюсть. Патент на полезную модель RU 202617 U1, 01.03.2021 г. Заявка № 2020117312/14(028971).
16. Чепуряева О.С., Клаучек С.В., Шемонаев В.И., Данилина Т.Ф., Михальченко Д.В., Шкарин В.В. Пластмассовый валик с пластмассовым базисом на верхнюю челюсть. Патент на полезную модель RU 213341 U1, 07.09.2022 г. Заявка № 2021130950.
17. Чепуряева О.С., Клаучек С.В., Шемонаев В.И., Поздняков А.М. Комплекс миогимнастических упражнений для тренировки и нормализации работы жевательных мышц пациентов с полным отсутствием зубов. Патент на изобретение RU 2812832 C1, 02.02.2024 г. Заявка от 22.03.2023.
18. Чепуряева О.С. Способ тренировки жевательных мышц пациентов с полным отсутствием зубов с использованием принципов биологической обратной связи. Патент на изобретение RU 2811761 C1, 16.01.2024 г. Заявка от 02.06.2023.