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AN INTEGRATED APPROACH TO THE DIAGNOSIS AND TREATMENT OF COMPLICATED FORMS OF CARIES IN PATIENTS AFTER CORONAVIRUS INFECTION

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CONTENT

INTRODUCTION

The relevance of the research topic

COVID-19 is a serious disease caused by the SARS-CoV-2 virus. This virus affects various organs both through direct infection and through the body's immune response. Finding a patient in a state of immunosuppression contributes to the development of diseases that can be caused by opportunistic viruses, bacteria and fungi, which under normal conditions do not cause pathology in healthy people without damage to the immune system.

Due to the spread of COVID-19, the number of oral diseases that occur in patients with previously transmitted COVID-19 is steadily increasing (Manak T.N., Matveev A.M. Lutskaya I.K., Yudina N.A., 2020).

At the moment, there is no direct evidence of what exactly is the root cause of the development and exacerbation of chronic diseases in the oral cavity after undergoing coronavirus infection. This may be the virus itself, as well as the effect of drugs that patients took during treatment (Romanov B.K., 2020, Nikiforov V.V., Suranova T.G., Mironov A. Yu., Zabozlaev F.G., 2020).

Among the diseases of the oral cavity that occur against the background of previously suffered COVID-19, lesions of the oral mucosa, periodontal diseases are especially common, multiple dental caries and its complications are also distinguished, represented by pulpitis and periodontitis (Borisova E.G., Mashkova N.G., Potocka A.V., Makedonova Yu.A., 2021, Liu J, Zheng X, Tong Q, Li W, Wang B, Sutter K, 2020).

Complicated forms of dental caries, according to statistics, are a common form of dental diseases, and despite significant advances in diagnosis, treatment and prevention, the number of patients with dental pulp and periodontal diseases ranges from 14% to 20% in the structure of dental care (Kumirova O.A., 2003).

Pulpitis is the most common form of dental caries complication. In patients who have previously had COVID-19, the most common form is chronic gangrenous

pulpitis, which has a number of characteristic clinical manifestations (Mitronin A.V., Apresyan N.A., Ostanina D.A., Yurtseva E.D., 2021).

The occurrence of periodontitis can be as an independent infectious lesion of periodontal tissues associated with the spread infections, and may also occur as a complication in previously endodontically treated teeth (Mitronin A.V., 2021).

According to the protocol and clinical recommendations (DAR, Clinical recommendations (treatment protocols), complicated forms of caries are treated endodontically by traditional methods, including the elimination of infection by removing inflamed and necrotic pulp from the entire root canal system, cleaning the infected dentin from the canal walls and giving it an appropriate shape, drug exposure with increased effectiveness of the drugs used, as well as the preparation of the entire root system (from the mouth to the apical opening) for its subsequent obturation (Dental Association of Russia, 2018).

Mozgovaya L.A. and co-authors (2017) in their research showed that Streptococcus has the main effect on dental caries, but as pathological processes in tooth tissues progress, their number decreases by 78% [10]. There is also a change in the species composition of microorganisms as the disease progresses: the number of Str. Sanguis (38.2%) and Str. Salivarius (45.4%) decreases, and vice versa, the activity of Str. Mitis (76.4%) and Str. Mutans (18.2%) prevails. Similar dynamics are observed with respect to Lactobacillus sp. (63.6%) and Bifidum bacterium sp. (67.3%) as the carious process progresses [8]. Colonization of the obligate microflora of Neisseria (16.4%) and fungi of the genus Candida (21.8%) is also noted and tends to increase [9, 8].

The degree of elaboration of the research topic

Literature data on the presence of yeast-like fungi in the pulpoperiodontal complex of the tooth in patients who have undergone COVID-19 are few. The authors of these reports suggest the possibility of fungi entering the pulp chamber of the affected tooth from the oral cavity.

An increase in the activity of opportunistic fungi of the genus Candida in the oral cavity in patients who underwent COVID-19 was not previously considered as a consequence of uncontrolled medication during self-prescribed treatment during COVID-19 or was not associated with the manifestation of the activity of the SARS-CoV-2 virus itself in the tissues of the oral cavity.

According to Russian and foreign literature, the occurrence of long-term complications after endodontic treatment in patients who had previously had COVID-19, as well as the lack of expected effectiveness of the standard treatment protocol used, had not previously been associated with the presence of Candida fungi in the root canal system of the tooth.

Previously, the diagnostic value, simplicity and accessibility of bacterioscopy for determining the bacterial component of the contents of the root canals of teeth affected by chronic gangrenous pulpitis or periodontitis in the acute stage in patients who had previously had COVID-19 at different times were not considered.

Based on the above, the goals and objectives of this dissertation research were formed.

The purpose of the study

Improving the effectiveness of endodontic treatment of complicated forms of dental caries, manifested against the background of COVID-19, by eliminating the identified fungal flora in the root canal system.

Research objectives:

1. To analyze a standard set of diagnostic measures for diseases of the pulp and periodontal teeth in patients who have previously had COVID-19.

2. To identify a group of patients who have undergone COVID-19, who are subject to special endodontic treatment for chronic pulpitis and periodontitis, based on the data of bacterioscopic and bacteriological studies.

3. To establish the most effective medicinal antimycotic drug in relation to the identified microflora of the root canals of teeth in patients who had previously been ill with COVID-19.

4. Modify the method of endodontic treatment, taking into account the identified microflora of the root canal system of teeth of patients who underwent COVID-19.

Scientific novelty of the dissertation research

1. The method of endodontic dental treatment for chronic pulpitis and periodontitis developed against the background of previously transferred COVID-19 has been modified.

2. The high diagnostic value of bacterioscopic examination and the need for its use at a clinical appointment by dentists to determine the fungal component in the endoperiodontal complex have been confirmed.

3. Theoretically justified and practically confirmed the need to include an antimycotic component in the algorithm of therapeutic and preventive measures in the endodontic treatment of patients who have had COVID-19.

Theoretical significance

1. According to clinical and laboratory studies, a high concentration of Candida fungi was detected in the contents of root canals in patients who had previously been ill with COVID-19.

2. The conducted studies make it possible to justify the need for the use of antimycotic drugs in the protocol for the treatment of pulpitis and periodontitis in the presence of Candida fungi in the root canal system of teeth in patients who have had COVID-19.

Practical significance

1. The necessity of bacterioscopy and bacteriology as a diagnostic method in choosing treatment tactics and predicting the results of treatment of pulpitis and periodontitis in patients who have undergone COVID-19 is substantiated.

2. A method is proposed to increase the effectiveness of the treatment of pulpitis and periodontitis in patients who had previously been ill with COVID-19 by using a modified method of endodontic treatment.

3. A comprehensive method has been developed for the treatment of complicated forms of dental caries in patients who have undergone COVID-19, including the use of the antimycotic drug Fluconazole.

Methodology and methods of dissertation research

The basis of the methodology of this dissertation research is the use of empirical and theoretical methods of scientific cognition. The dissertation was carried out in the design of a statistical and non-randomized study using clinical and laboratory methods.

The study involved 117 dental patients who had previously been ill with COVID-19 at different times (from 1 month to 1 year), aged 21 to 40 years, among whom were both men and women who did not have a concomitant somatic pathology. The criteria for exclusion from the study were: the presence of severe somatic diseases, participation in another study in parallel, as well as rejection of the study.

The patients underwent a standard set of diagnostic measures, including the collection of a life history and anamnesis of the disease, external examination and examination of the oral cavity, probing, thermal sampling and percussion, as well as X-ray diagnostics and electrodontodiagnostics. These measures made it possible to diagnose and, according to this criterion, divide patients into 2 groups: chronic gangrenous pulpitis and exacerbation of chronic periodontitis.

In the future, patients underwent additional laboratory research methods – bacterioscopic and bacteriological. According to the data obtained, the patients were divided into 4 groups:

Group 1 consists of 36 patients diagnosed with chronic gangrenous pulpitis, standard endodontic treatment was performed according to the protocol.

Group 2 consists of 33 people, the diagnosis is "chronic gangrenous pulpitis", a complex modified endodontic treatment using an antimycotic companion was performed.

Group 3 – 25 people, diagnosis of "exacerbation of chronic periodontitis",

standard endodontic treatment was carried out according to the protocol.

Group 4 consists of 23 people, diagnosed with "exacerbation of chronic periodontitis", complex modified endodontic treatment using an antimycotic component was performed.

The long-term results of the treatment were evaluated at a follow-up examination, as well as using X-ray examination methods.

The obtained research results were processed statistically using the Statistica program.

Main scientific results

1. The complex of diagnostic measures proposed and used in practice, which includes, in addition to standard diagnostic measures, bacterioscopic examination and bacteriological examination, proved to be more informative in patients who had previously been ill with COVID-19 in order to determine further treatment tactics [20, p.80]. The results are published in [20]. The author's personal participation in obtaining these results: collecting material, interpreting the results, writing the text of the article.

2. Bacterioscopic examination of the contents of the root canals of the tooth of patients who had been ill with COVID-19 made it possible to identify elements of yeast-like Candida fungi in 83.8% of cases. And also to identify young and mature forms of pseudomycelia, which indicates the high activity of Candida fungi [24, p.87]. The results are published in [24]. The author's personal participation in obtaining these results: collecting material, interpreting the results, writing the text of the article.

3. With the help of bacteriological research, the previously obtained data on bacterioscopy of smears of the contents of root canals in patients who had previously suffered COVID-19 were confirmed and specified by sowing the material on nutrient

agar and identifying Candida Albicans fungi [21, pp.65, 90]. The results are published in [21]. The author's personal participation in obtaining these results: collecting material, interpreting the results, writing the text of the article.

4. "Fluconazole" has been identified as the most effective antifungal drug in relation to the identified mycotic component in the pulpoperiodontal complex of teeth during endodontic treatment in patients who have had COVID-19 [11, p.97]. The results are published in [11]. Personal participation of the author in obtaining these results: collecting material, interpreting the results, writing the text of the article.

5. Despite compliance with all clinical recommendations during endodontic treatment of pulpitis and periodontitis in patients who had previously had COVID-19, in some cases it is not possible to achieve the desired effect due to the resistance of biofilms containing Candida albicans, Prevotella melaninogenica, Enterococcus faecalis, Bacteroides fragelis in the root canal system to the effects [52, p. 40, 41]. The results are published in [52]. The author's personal participation in obtaining these results: collecting material, interpreting the results, writing the text of the article.

6. The proposed comprehensive approach for treating complicated forms of dental caries in patients who have previously recovered from COVID-19, which includes temporary exposure of the drug "Fluconazole" in prepared root canals and take in of 150 mg of the drug orally, has proven to be more effective according to the studies [56, p. 75]. The results are published in [56]. The author’s personal participation in obtaining these results: collecting material, interpreting the results, writing the text of the article.

7. The biological method for treating pulpitis has not gained widespread adoption due to the challenges in predicting long-term outcomes, especially when planning orthopedic treatment, and in determining the reversibility of the inflammatory process. Additionally, creating sterile conditions during treatment presents difficulties, increasing the likelihood of complications [22, p. 36]. The results are published in [22]. The author's personal participation in obtaining these results: collecting material, interpreting the results, writing the text of the article.

The results of the study are used in the educational process and practical activities of the Department and Clinic of General Dentistry of the Military Medical Academy named after S.M. Kirov.

The materials of the dissertation were presented at: the All-Russian scientific and Practical Conference "Theoretical and practical issues of clinical dentistry" (St. Petersburg, 2021, 2023), the XXIV International Congress "Health and Education in the XXI Century" (Moscow, 2022), the All-Russian scientific and practical Conference "Topical issues of maxillofacialfacial surgery and dentistry" (St. Petersburg, 2022), in the project "Young Scientists of St. Petersburg" (St. Petersburg, 2023).

The main provisions of the dissertation were reported and discussed at a joint meeting of the Departments of General Dentistry, Maxillofacial Surgery and Surgical Dentistry of the Military Medical Academy named after S.M. Kirov.

9 publications have been published on the topic of the dissertation, among which 5 are in publications recommended by the Higher Attestation Commission of the Russian Federation, participation in writing 2 chapters in the educational and methodological manual. Patent for invention No. 2810424 "Method for the treatment of chronic gangrenous pulpitis in patients who have had COVID-19, when mycotic flora is detected in the tooth pulp" was obtained.

The main results and provisions of the dissertation research are presented in publications:

1. Borisova, E. G. Diagnosis and treatment of chronic gangrenous pulpitis in the detection of mycotic flora after a coronavirus infection / E. G. Borisova, A. L. Ermolovich // Medico-pharmaceutical journal "Pulse". – 2023. – Vol. 25, No. 2. – pp. 11-16. DOI: 10.26787/nydha-2686-6838-2023-25-2-11-16.

2. The influence of diabetes mellitus on the success of treatment of chronic periapical periodontitis / A. L. Ermolovich, Yu. B. Vorobyova, A.V. Pototskaya, A. A. Komova // Maestro of Dentistry. – 2021. – № 2 (76). – pp. 21-24.

3. Ermolovich, A. L. Features of the diagnosis of complicated forms of dental caries in patients who had previously been ill with COVID-19 / A. L. Ermolovich, E.

G. Borisova, V. A. Zheleznyak // Theoretical and practical issues of clinical dentistry: Materials of the All-Russian Scientific and Practical Conference. (St. Petersburg, 05-06 October 2023): sat. tr. / ed.: Sh. A. Kerimov. – St. Petersburg : Publishing house of Military Medicine. S. M. Kirov Academy of Sciences, 2023. – pp. 31-33.

4. Ermolovich, A. L. Features of the mycotic flora of the endodonts in patients who have undergone COVID-19 / A. L. Ermolovich, E. G. Borisova, D. D. Semenova // Russian Dental Journal. – 2024. – vol. 28, No. 1. – pp. 47-52. DOI: 10.17816/dent627649.

5. Ermolovich, A. L. Prevention of pulpitis of a vital tooth previously prepared for orthopedic construction / A. L. Ermolovich, Yu. B. Vorobyova, A.M. Kovalevsky // Medico-pharmaceutical journal "Pulse". - 2022. – Vol. 24, No. 5. – pp. 52-56. DOI: 10.26787/nydha-2686-6838-2022-24-5-52-56.

6. The importance of bacterioscopy in the complex diagnosis of complicated forms of dental caries in patients who previously had COVID-19 / A. L. Ermolovich, E. G. Borisova, V. A. Zheleznyak, Yu. A. Khrustaleva // Applied information aspects of medicine. – 2023. – vol. 26, No. 3. – pp. 41-46.

7. Features of endodontic treatment of the tooth, taking into account the identified Candida albicans in the root canal system in patients / A. L. Ermolovich, E. G. Borisova, A. F. Specivets, V. A. Zheleznyak // Medical and pharmaceutical journal "Pulse". – 2024. – vol. 26, No. 4. – pp. 21-26. DOI: 10.26787/nydha-2686-6838-2024-26-4-21-26.

8. Patent No. 2810424 C1 Russian Federation, IPC A61C 5/00 (2006.01), A61K 6/00 (2006.01), A61K 31/4196 (2006.01), A61P 1/02 (2006.01). Method of treatment of chronic gangrenous pulpitis in patients who have had COVID-19, when mycotic flora is detected in the tooth pulp : No. 2023113284 : application 05/23/2023 : publ. 12/27/2023 / Borisova E. G., Ermolovich A. L. ; patent holder Federal State Budgetary Military Educational Institution of Higher Education "Military Medical Academy named after S.M. Kirov" of the Ministry of Defense of the Russian Federation (VMedA). – p. 10.

9. Therapeutic dentistry : A textbook / VMA named after S. M. Kirov, Ministry

of Defense of the Russian Federation. Federation ; edited by V. A. Zheleznyak, A.M. Kovalevsky. – St. Petersburg : Publishing House of the S. M. Kirov VMA, 2023. – Part 2. – p. 296.

The dissertation conducted an analysis of 127 sources of foreign and domestic literature. The author personally examined 117 patients, conducted basic diagnostic methods, collected material for laboratory diagnostic methods, and performed bacterioscopy. The obtained results of laboratory studies (bacterioscopy and bacteriology) are analyzed. Statistical data processing was performed, and the Statistica program was used. A method of endodontic treatment of pulpitis and periodontitis of teeth in patients who had previously been ill with COVID-19 has been developed. The conclusions of the study are formulated and practical recommendations for dental therapists are given. The share of the dissertation's participation in clinical research was 100%, in laboratory research – 68%, in statistical data processing - 85%.

Provisions to be defended

1. Analysis of diagnostic methods for complicated forms of dental caries in patients who have had COVID-19 in order to determine indications for endodontic treatment.

2. A group of patients who have had COVID-19, subject to special antimycotic treatment, identified at the stage of bacterioscopy of the contents of the root canals of teeth.

3. "Fluconazole" is an effective antifungal drug against fungi in the inflamed pulp and root canal system of the tooth.

4. The tactics of endodontic treatment of diseases of the pulpoperiodontal complex of teeth in patients who have undergone COVID-19 have been modified.

CHAPTER 1. LITERATURE REVIEW

1.1. Clinical manifestations in the oral cavity in patients after COVID-19

Coronavirus infection is an acute viral disease with a predominant lesion of the upper respiratory tract caused by an RNA genomic virus of the genus Betacoronavirus of the family Coronaviridae (SARS-CoV-2) [17, 46, 64, 106, 120]. This virus affects various organs both through direct infection and through the body's immune response. It occurs in varying degrees of severity – from mild to severe forms of the disease. The defeat of a new coronavirus infection is often accompanied by the occurrence of various complications, among which the occurrence of viral pneumonia is in the first place. There are also complications associated with other systems of internal organs (heart, kidneys, nervous system, pancreas and thyroid glands, liver and others) [17, 46, 54, 69, 120]. In addition to the above, damage to the body by the SARS-CoV-2 virus can also provoke: diabetes, heart damage, immunodeficiency conditions, impaired fat metabolism and other metabolic disorders [17, 46, 106, 108]. For this reason, some researchers believe that COVID-19 is also a multi—organ metabolic disease [46, 54, 69].

The results of various oral examinations in dental patients who have undergone COVID-19 demonstrate a variety of manifestations of dental diseases in the oral cavity [13, 49, 64]. At the moment, there is no direct evidence of what exactly is the root cause of the development and exacerbation of chronic diseases in the oral cavity after undergoing coronavirus infection. This may be the virus itself, as well as the effect of drugs that patients took during treatment [13, 17, 64]. Also, one should not forget that the oral cavity is a favorable environment for the existence and reproduction of many types of anaerobic and facultative anaerobic microorganisms that activate their activity against the background of various causes, among which one can distinguish the state of immunodeficiency of the body, damage to internal organs and their systems, diabetes mellitus, leukemia, radiation and chemotherapy for oncological diseases, deficiency of B vitamins, as well as against the background of

irrational intake of medications (antibiotics, corticosteroids, oral contraceptives, abundant and constant use of antiseptics in the oral cavity) and other conditions [13, 33, 60].

Due to the widespread spread of COVID-19, the number of dental patients with various oral diseases developing against the background of a new coronavirus infection is steadily growing. Patients with a history of COVID-19, with various diseases of the oral cavity, applied to the dental clinic for dental care. Among such patients there are both men and women, all of different age categories. Among them, lesions of the oral mucosa, periodontal diseases are particularly common, and multiple dental caries and its complications, represented by pulpitis and periodontitis, are also distinguished [13, 17, 64]. The vast majority of patients noted that they had not previously experienced symptoms of the disease, but manifested themselves after a coronavirus infection.

There are studies that demonstrate the expression of ACE-2, a receptor of the SARS-CoV-2 virus, in oral tissues [39, 63, 85]. In patients who have suffered from COVID-19 in severe or moderate severity, cytokine storm and abundant secretion of proinflammatory cytokines such as IL-6, IL-1β and TNF-α in various oral pathologies, which include pulpitis, periapical periodontitis, periodontitis, suggest that the inflammatory microenvironment is distinctive a feature of both COVID-19 and oral diseases [39, 63, 85]. The resulting hyperinflammation can create a favorable microenvironment for the growth of pathogenic and opportunistic microbial organisms, as well as have a detrimental effect on the integrity of oral cavity tissues, hard tissues and neurovascular bundle [63, 85].

In this regard, it is possible to develop various diseases of the oral mucosa: lichen planus, chronic aphthous stomatitis, candidiasis, ulcerative lesions of the oral mucosa [13, 49, 64]. Also, a large number of patients note the appearance of dry mouth and dryness of the red border of the lips, impaired perception of taste sensations, xerostomia, bad breath. Impaired or lost sense of smell also affects the taste sensations when eating. These violations can be absolute and relative [20, 64]. The cause of halitosis may be respiratory infections, gastrointestinal tract damage, the

presence of abundant plaque and overlying on the back of the tongue [20, 64]. At the same time, men are less likely to report the presence of halitosis than women [13, 64]. Complaints of xerostomia are also present in most patients, regardless of gender [13, 20, 64]. Dry mouth may be caused by taking medications or develop against the background of systemic diseases [20, 64]. This pathology affects the development of diseases caused by periodontal pathogenic factors and infectious lesions of the oral cavity, for example, candidiasis [64]. In patients, the visible mucous membrane of the red border of the lips is dry, cracks and flakes [13, 49].

The new coronavirus infection also had an impact on the bloodstream supplying various organs of the oral cavity. Local arteriole spasm is an early sign of impaired capillary blood flow. This causes stagnation in the venular link of the microcirculatory bed. Thus, there is a change in the intensity of blood flow in the capillaries [13, 64]. Such changes are important in the pathogenesis of many diseases, such as periodontitis, periodontitis, various forms of pulpitis and periodontitis [13, 14]. Pronounced disturbances in the microcirculatory bed lead to a violation of the trophic organs of the oral cavity and, as a result, lead to the progression of dystrophic and inflammatory processes in the tissues of the pulp and periodontium of the tooth [13, 14, 54]. Thus, the risk of developing pulp diseases increases, in particular chronic pulpitis, which can develop rapidly, moving from the acute phase [49, 64]. Morphological studies of the dental pulp of patients who had previously undergone COVID-19 demonstrated the processes of destruction of odontoblast and fibroblast cells, as well as microvessels, collagen, reticulin and nerve fibers. In addition, pathological changes corresponding to necrobiosis and necrosis of the tooth pulp were observed, which may indicate the development of such a form of chronic pulpitis as gangrenous pulpitis [13, 14, 49, 60]. According to the above-mentioned pathological changes in the tooth pulp, another common disease, against the background of COVID-19, is periodontitis.

Many patients who sought help at a dental clinic, which was 48% according to the study, noticed the appearance of erosions and ulcers on the mucous membrane of

the cheeks [13, 49]. These patients complained of painful sensations when eating various foods, chewing and swallowing, as well as when talking [13, 49].

Candida fungi were found in 28.84% of the total number of patients diagnosed with lichen planus and chronic recurrent aphthous stomatitis, as well as in 9 (13.04%) patients diagnosed with multiple caries [13, 49]. After conducting a bacteriological study, Candida fungi were identified in many patients and candidiasis was diagnosed. Fungi of the genus Candida are normally present in 40-60% of people and belong to conditionally pathogenic microorganisms of the oral cavity [11, 41, 30, 66, 95]. But an increase in CFU leads to clinical candidiasis [11, 41, 67]. At the moment, it has not been proven what exactly is the root cause of the development of candidiasis: This can be either the coronavirus infection itself, or unauthorized or prescribed administration of antibacterial drugs during treatment [11, 67, 13]. Also, in addition, patients complain of dryness and burning, bad breath, changes in taste sensations, pain when eating, which are characteristic complaints for candidiasis [11, 13, 49, 64]. Such patients are prescribed antifungal drugs, after which the complaints stop [11, 13, 49, 64].

Chronic recurrent aphthous stomatitis is also the most common oral disease in patients who have previously had COVID-19 [13, 14, 64]. Presumably, the etiology in this case is associated with a violation of cellular and humoral immunity [13, 64]. In etiopathogenesis, the leading factor is the cross-immune response. As a result, aphthae are formed in the oral cavity [13, 14, 64]. Over time, depending on the severity, the number of afts becomes greater, and their healing time is prolonged to 2-4 weeks [13, 49].

Based on the data of the conducted studies of patients with the presence of COVID-19 in previous diseases, it is possible to justify the expediency and necessity of including in this category of patients, in addition to standard dental examination, additional examination methods (blood test, bacteriological examination, microcirculatory examination, and others) before starting any dental treatment. It is important to diagnose dental manifestations in time and choose the most adapted algorithm for the treatment of pathology, depending on the clinical manifestations in

the oral cavity [69, 108]. It is worth remembering that even the asymptomatic COVID-19 disease leaves behind long-term consequences and complications, which include a weakening of immunity and an increased tendency to autoimmune processes, including in the oral cavity. Thus, there is a need to carry out and prescribe therapeutic and preventive complexes of measures, the purpose of which will be to prevent the development of a particular pathology of the oral cavity, their complications [13, 46, 49, 65].

1.2. Pathogenesis and clinical picture of chronic gangrenous pulpitis and exacerbation of chronic periodontitis

Pulpitis is the most common form of dental caries complication. Acute and chronic forms of pulpitis are distinguished [10, 74]. Chronic pulpitis may be an independent disease, or it may be a consequence of acute pulpitis. The most common applications are the WHO classification (1997), as well as the clinical and anatomical classification of E.E. Platonov (1968) [10]. According to the classification developed by the Moscow Medical Dental Institute in 1989, there are: acute pulpitis, chronic pulpitis and exacerbation of chronic, among which acute has 2 forms – focal and diffuse, chronic 3 forms – fibrous, hypertrophic, gangrenous [10, 75]. The stages of exacerbation are distinguished in chronic fibrous pulpitis and chronic gangrenous [10, 74, 75].

H.S.Simon (1987) indicates that the pulp responds to the carious process with an inflammatory reaction, since the dentine tubules are permeable to microorganisms and their toxins. In the pulp of the tooth, collateral blood circulation is damaged and disrupted. When an increase in intrapulpar pressure occurs, there is a significant deterioration in the blood circulation of the pulp, followed by the development of hypoxia and foci of pulp necrosis begin to form [9, 35, 78]. Increased permeability of tooth tissues contributes to the further spread of the inflammatory process due to the decomposition products of pulp tissues [60]. Thus, the process becomes irreversible, a microabcess and leukocyte infiltration zones are formed, purulent decay occurs, which leads to the formation of necrosis of the tooth pulp [9, 35, 78]. First, necrotic areas are formed, hence there is a violation of the blood supply to the tooth, as well as a decrease in the immune properties of the pulp [9, 35, 60, 78]. Thus, chronic gangrenous pulpitis develops. Foci of tissue decay formed in chronic gangrenous pulpitis are separated from the underlying inflamed pulp by a demarcation shaft of granulation tissue.

Each form of pulpitis has its own peculiarities of the course of the pathological process and its own nature of inflammation of the dental pulp tissues, which is manifested by specific clinical signs inherent in a certain form of pulpitis [10, 74].

As the active activity of the microflora manifests and the pathological process spreads in the tooth pulp, the patient complains of spontaneous aching pains, previously pain from all types of irritants was observed [9, 35, 78]. The intensity of the pain that occurs depends on how much the process of pulp necrosis has spread and on the duration of the inflammatory process. If the necrosis site is small in size, and the rest of the crown and root pulp remains capable of perceiving stimuli, then the nature of the pain will be more pronounced. With a greater spread of the necrotic process to other areas of the pulp, sensitivity to the previously indicated stimuli is significantly reduced. In this case, pain sensations arise from stronger stimuli, for example, when eating hot food. In addition, there may be complaints about unsatisfactory aesthetics (in the case when the crown part of the tooth changes color to gray due to the decay of the pulp), bad breath [9, 35, 54, 78].

During an examination of the oral cavity, it is most often determined that the tooth has changed in color, a deep carious cavity filled with pigmented and softened dentin is revealed [9, 35, 54, 75, 78]. The carious cavity can often communicate with the tooth cavity, and a dirty gray pulp can be visualized in the communication area. A putrid odor may come from the cavity. Probing is often painless [9, 35, 54, 75, 78]. But a painful reaction can be noted with deep probing in the area of the mouths of the root canals or when working with a metal endodontic instrument when touching the root pulp [9, 35, 54, 75, 78]. The thermal test will be positive for hot. The percussion is weakly positive. The electrodontometry index is 60-90 μA [9, 35, 54, 75, 78].

In adult patients among the population of the Russian Federation, periodontitis occupies the third place in the structure of dental morbidity, which is 30-50% among dental diseases of the oral cavity [54].

It has long been established (B.C. Ivanov, 1984) that in the pathogenesis of periodontitis, the restructuring of reactivity on the part of periodontal tissues, which occurs under the influence of sensitization by microorganisms and their toxins, as

well as decay products of tooth pulp, is of great importance [54, 71]. Periodontitis has an infectious origin and occurs under the influence of non-specific pathogens that can act independently or in combination with other microorganisms [54, 71]. A feature of the pathogenesis of periodontitis is a decrease in the body's resistance to the repeated introduction of the pathogen [54, 71]. Infection spreads from the carious cavity into the pulp chamber to the pulp of the tooth, then causes irreversible changes in the pulp itself, then the infection spreads to periodontal tissues [54, 71].

Most often, exacerbation occurs in two forms of periodontitis – granulating and granulomatous, but in rare cases, the fibrous form may also worsen.

With an exacerbation of periodontitis, pain is constant, which increases with stress on the tooth, for example, at the time of chewing food [10, 35, 74, 75, 113]. Pain can rarely radiate along the branches of the nerve. Patients also note the slight mobility of the tooth and the "feeling of a grown tooth." The tooth bothered the patient earlier, against the background of a painful attack, the patient takes painkillers to relieve pain. There may be a deterioration in the general condition, an increase in temperature (380-390) [35, 74, 75]. The patient may complain of headache, dizziness, weakness.

During an external examination, a possible change in the configuration of the face is revealed due to collateral edema of soft tissues from the side where the causal tooth is located, the opening of the oral cavity is more often not disturbed, regional lymph nodes may be enlarged, painful on palpation [35, 74, 75].

The tooth may be intact, may have an extensive filling, there is a deep carious cavity, the color of the tooth crown is unchanged, the carious cavity does not communicate with the tooth cavity. The mucous membrane in the area of the diagnosed tooth is hyperemic, edematous, painful on palpation. Probing of the bottom and walls of the carious cavity is painless, there is no reaction to thermal stimuli, percussion (vertical, horizontal) of the tooth is painful [35, 75, 78]. The radiograph determines the form of periodontitis, which precedes the stage of exacerbation [35, 75, 78]. For example, for chronic granulating periodontitis in the acute stage, there is a characteristic blurring of the bone pattern, and for chronic

granulomatous periodontitis in the acute stage, there is a reduced clarity of the boundaries of the focus of bone tissue dilution. The EOT is approximately 120-150 μA [9, 19, 35, 75, 78].

It should be borne in mind that the data obtained from the clinical examination of the patient do not always allow the dentist to carefully diagnose changes in the tissues of the tooth pulp, which may lead to the choice of an irrational treatment method [42, 44].

1.3. Methods of diagnosis of complicated forms of dental caries

As you know, all diagnostic methods in dentistry are divided into basic and additional. The main ones include: survey, external examination, examination of the vestibule and oral cavity, palpation, percussion sounding. Additional: temperature test for a cold or hot stimulus, electro-dental diagnostics, X-ray research methods, laboratory methods (cytological, bacteriological, histological, blood, saliva analysis, and others), and special studies [10, 49, 67, 74].

Also, diagnostic methods are divided into clinical and paraclinical. Clinical methods include the main methods of examination of the patient, such as examination, percussion, palpation, questioning and questioning. Paraclinical methods involve the use of additional special equipment. These include: X-ray methods, electroodontometry, face measurement from photographs, myotometry and many others [10, 49, 67, 74].

The research methods used in dentistry can also be divided into subjective ones, which are based on data received from the patient and thus demonstrate his opinion [60, 67, 74]. These include: interviewing the patient (collecting medical and dental history), complaints. Objective diagnostic methods are based on the data obtained by a specific method. These include: external examination, palpation, percussion, auscultation, examination of the oral cavity and its vestibule, thermodiagnostics, physical and X-ray methods, laboratory examination methods, calculation of diagnostic models, photographing [10, 49, 60, 67, 74].

The problem of diagnosis and treatment of pulpitis and periodontitis, despite its intensive development, has remained relevant in dentistry for a long time and today [48, 67].

The first thing the dentist finds out at the initial appointment is what complaints the patient has. He further relies on these subjective data to make a preliminary and final diagnosis [10, 49, 67, 74]. As mentioned earlier, this method is very subjective, since the doctor receives information from the words and feelings of the patient, but it is the starting point in building a further diagnostic scheme and

treatment plan [10, 49, 67, 74]. Evaluating the patient's complaints and carefully collecting anamnesis in most cases only allows the patient to suspect the presence of inflammation of the tooth pulp or periodontal [10, 49, 67, 74]. The clinical picture of the disease can be quite inaccurate - blurred and veiled – due to the fact that the patient may notice subjective sensations, which in the case of such forms of diseases as gangrenous pulpitis and exacerbation of chronic periodontitis in most cases are indefinite [10, 49, 67, 74].

Anamnesis is divided into: anamnesis of life and disease. The dentist finds out how long the patient has considered himself sick, what he associates with the appearance of complaints, the dynamics of the disease, which makes it worse, and what on the contrary brings relief, and so on. The doctor gives the patient a health questionnaire, where it is necessary to indicate the diseases suffered, as well as the presence of chronic diseases, injuries and operations, medication, allergic status, oncological diseases and possible chemotherapy or radiation therapy [10, 49, 67, 74].

Next, the doctor conducts an external examination, an examination of the vestibule of the oral cavity. And then the dentition and the teeth themselves. In chronic gangrenous pulpitis, the configuration of the patient's face remains unchanged, the skin is of physiological color, no changes in the temporomandibular joint are observed during palpation and auscultation, peripheral lymph nodes are not palpated, painless [10, 49, 67, 74]. In case of exacerbation of chronic periodontitis, the results obtained will depend on the form of periodontitis (slight swelling of soft tissues is possible, painful palpation along the transitional fold) [10, 49, 67, 74].

When examining the affected tooth, a deep carious cavity is most often found, the color of the crown has a grayish tinge, loses its luster. The cavity can be opened. Deep probing of the mouths of root canals can be painful. Non-bleeding, gray-coated surface layers of pulp are revealed [10, 49, 67, 74]. A temperature test for a thermal stimulus causes a slow increase in pain and its gradual extinction. Tooth percussion is painless [10, 49, 67, 74].

In the case of exacerbation of chronic periodontitis, the causal tooth may be intact, an extensive filling or carious cavity communicating with the tooth cavity may

be determined, the mucous membrane in the area of the affected tooth is hyperemic, edematous, painful on palpation, infiltration is determined. Probing of the mouth of the root canal is painless, there is no reaction to thermal stimuli, tooth percussion is painful, tooth mobility is possible [10, 35, 49, 67, 74, 78].

After carrying out all the main diagnostic methods for complicated forms of dental caries, the dentist proceeds to additional diagnostics.

Electroodontodiagnosis allows you to determine the electrical excitability of the tooth pulp and is carried out using a special device while determining the viability of the tooth pulp using an electric current [10, 49, 67, 74]. In pulpitis, electrodontodiagnosis makes it possible to clarify the degree and prevalence of inflammation, to differentiate a limited process from a diffuse one. A marked decrease in electrical excitability (25-60 μA) indicates the prevalence of the pathological process in the crown pulp, and the pulp reaction above 60 μA indicates the death of the crown pulp [10, 49, 67, 74]. The transition of inflammation to the root pulp corresponds to a threshold current value of 61-100 μA [9, 23, 33, 78].

X-ray examination of patients is a mandatory and integral part of any examination scheme for patients with lesions of the pulp and periodontium of the tooth. The most common X-ray methods are: sighting of one or more teeth, orthopantomography, computed tomography of the upper and lower jaw [9, 28, 51, 78].

Computed tomography is the most modern and informative method of X-ray examination of the condition of all bone structures and oral cavities of patients. But the cost of the equipment does not allow clinics to introduce it into a mandatory and accessible part of the diagnostic and treatment plan [73].

Thus, the most common X-ray examinations were targeted radiography and orthopantomography [10, 68].

In chronic gangrenous pulpitis, no changes are most often observed on the X-ray. But in some cases, it is possible to detect the presence of changes in the periapical tissues: the expansion of the periodontal fissure. In the case of exacerbation of chronic periodontitis, the X-ray picture takes the form of the form of periodontitis

that was in the chronic stage. It can be either granulating or granulomatous [10, 26, 49].

Visual assessment of the condition of the tooth pulp (simple and extended pulposcopy according to Kunin A.A., 1973) is a method that allows for differential diagnosis of diseases of the pulpoperiodontal complex, determine the features of the pulp surface, its color, assess the condition of surrounding tissues, and thus draw conclusions about the possible nature of inflammation [12, 15, 28, 32].

Bacterioscopic examination makes it possible to determine the nature of the inflammatory process by identifying the composition of the flora of the root canals. Many authors note the importance of bacterioscopy for the detection of oral microflora, especially fungal, as a simple and affordable method of additional diagnosis [12, 15, 28, 83].

The list of indications for bacterioscopy is wide. For this type of study, a native preparation is used or stained with different techniques and dyes (for example, colored according to Gram, Zil-Nilson, Romanovsky-Giemse) [12, 28, 83]. The most accurate representations of the microbial landscape are given by colored preparations. In addition to classical dyes, it is also recommended to use Leffler's methylene blue, a polychrome solution of methylene blue [12, 28, 83].

The bacterioscopy method, as one of the diagnostic methods, provides a good opportunity to detect yeast-like fungi of the genus Candida, as well as their pseudomycelia. The cells of fungi of the genus Candida reproduce by budding, as well as with the help of pseudomycelia [32]. It has the appearance of elongated cells that touch a narrow base and consist of blastospores [15, 32, 72, 83, 107].

This diagnostic method makes it possible to determine the state of pathogenicity or carrier of the organism: a significant number of cells indicates pathogenicity, while if isolated representatives are found in rare fields of vision, they can be defined as carrier [12, 72, 77, 107].

The reliability of the diagnostic results depends on a number of factors, such as the technique of taking the material, the specifics of its transportation to the

laboratory, the correctness of material intake, storage conditions and time, and others [12, 77].

Since it was found that microorganisms form various colonies, a cultural research method is used to more accurately identify inflammatory agents, in which the patient's material is sown into a special environment favorable for the reproduction of microorganisms in order to further identify pathogens [12, 28, 70, 72, 77, 83].

Good growth and formation of large Candida colonies are noted when sowing on Saburo medium, wort-agar, carrot and potato agar, beer wort [32, 84, 85, 86]. The resulting fungal colonies are identified by the nature of colony growth, chlamydospore formation, enzymatic activity and type of filamentation [32, 84, 85, 86]. During the study, visual cultural signs are noted, such as: raised and more mature colonies or round smooth colonies of creamy consistency, with a fine-grained, folded or rough surface with a clear definition of the characteristics of individual species [32, 84, 85, 86].

The study of microflora in lesions of the pulp and periodontium of the tooth has demonstrated its extreme diversity. It is worth noting that in the surface layers of the pulp there is a pronounced microbial polymorphism, while in its deep layers there is a uniformity of microflora [25, 65].

When the acute inflammatory process of the tooth pulp turns into a chronic one, it is worth not forgetting about the ability of microorganisms to unite in associations, and in this case it increases [25, 65, 73]. In acute forms of pulpitis, associations are found in 6.4% of cases, while in chronic processes in 93.3% [61, 62].

The possibility of bacterioscopic and bacteriological examination allows the dentist to individualize the approach to the treatment of pulpitis and periodontitis, depending on the nature of inflammation of the pulp, the microbial component of the root canals, as well as to anticipate possible complications and take preventive measures, thereby to some extent predict the outcome of this disease.

1.4. Microbial composition of the pulpo-periodontal complex in pulpitis and periodontitis

The main etiological factor in the development of inflammatory processes in the tooth pulp and in the periodontal tissues of the teeth are microorganisms of the oral cavity, which can be represented by monocultures, as well as associations that cause inflammation in the tooth pulp [16, 30, 61]. Early studies mainly highlight the role of staphylococci and streptococci. But the subsequent improvement of diagnostic methods made it possible to identify various associations of microorganisms in the development of existing forms of pulpitis and periodontitis [16]. Research by Zorina O.A. and co-authors (2017) demonstrated that microorganisms forming different colonies and having different sensitivity to diagnostic tests that are used to identify microorganisms, and thus explained the reason for the differences in the detection of various microorganisms in the studied material [50, 61].

According to research, the quantitative and qualitative composition of the microflora of the tooth pulp at the stage of inflammation is represented by: Streptococcus 48,3% (sanguis, mutans, intermedius, mitis), Enterococcus spp. 45,1%, Staphylococcus 9,7% (haemolyticus, epidermalis), Fusobacterium spp. 9,7%, Peptostreptococcus spp. 7,5%, Candida spp. 5,9% [37, 60].

In acute forms of pulpitis, streptococcal or staphylococcal is more often detected, in chronic forms - mixed microflora. According to research by Richard J. Lamont and co-authors (2010), the most frequently seeded microorganisms from infected root canals of teeth are Bacteroides (70%), Prevotella (60%), Lactobacillus (51%), Oral Streptococci (41%), Clostridium (36%), Fusobacterium (33%), Eubacteria (20%), Actinomyces (16%), Candida (10%), Staphylococcus (7%), Enterococcus (3%) [39].

According to research, Kukushkina V.L. and co-authors (2017), microorganisms such as Staphylococcus (9.7%), Streptococcus (50%), Lactobacillus (41.7%), Neisseria (16.7%), Enterobacterium (8.3%), Enterococcus (8.3%), Candida (4.2-24.5%), as well as anaerobes, among which Peptococcus (42.8%),

Peptostreptococcus (21.4%), the Bacteroides family (21.4%), bacteria of the genus Fusobacterium (7.1%) and Prevotella (7.1%) were isolated [40].

Other studies by the authors (Belenova I.A. Vanina E.P., Kramyr V.O.) indicate that with the progression of inflammatory processes in the tooth pulp, the species composition of the microflora of the root canals of the tooth changes, in which the number of peptostreptococci decreases and the content of fusobacteria and bacterioids increases [7, 60, 99]. Association contributes to an increase in the virulence of microorganisms, which is manifested to a greater extent in anaerobes and yeast-like fungi [8, 60, 63, 85].

Mozgovaya L.A. and co-authors (2017) in their research showed that Streptococcus has the main effect on dental caries, but as pathological processes in tooth tissues progress, their number decreases by 78% [84]. There is also a change in the species composition of microorganisms as the disease progresses: the number of Str. Sanguis (38.2%) and Str. Salivarius (45.4%) decreases, and vice versa, the activity of Str. Mitis (76.4%) and Str. Mutans (18.2%) prevails. Similar dynamics are observed with respect to Lactobacillus sp. (63.6%) and Bifidum bacterium sp. (67.3%) as the carious process progresses [41]. Colonization of the obligate microflora of Neisseria (16.4%) and fungi of the genus Candida (21.8%) is also noted and tends to increase [41, 84].

The authors of various reports suggest the possibility of fungi entering the pulp chamber of the affected tooth from the oral cavity [11]. Candida albicans can be found on the mucous membrane of the oral cavity, as well as in the carious cavity, the root canal system of affected teeth [11]. Representatives of yeast-like fungi of the genus Candida are conditionally pathogenic microorganisms in the oral cavity, and their vital activity does not manifest itself in a normal state of health of the body [30, 41, 60, 66, 95]. But when conditions change, for example, when the immune state changes and the virulence of fungi increases, there is an opportunity for accelerated growth, adhesion and colonization [30, 41, 60, 66, 95]. This process is associated with the influence of various factors that reduce the body's resistance. These include disorders of the endocrine, digestive and hematopoietic systems, increased blood

circulation, metabolism, various oncological diseases, long-term chemotherapy, AIDS and other diseases [60]. Also, many authors attribute this to the long-term and irrational use of various pharmacological drugs: antibiotics, antiseptics, cytostatics, oral contraceptives [33, 60].

Candida albicans are oval–shaped cells, ranging in size from 3 microns to 5 microns, which can exist at pH= 5.8-6.5, i.e. in an acidic environment [60, 90, 93]. Their cells are capable of producing a large number of enzymes that break down lipids, carbohydrates and proteins [60, 93].

It has been proven that the possibility of Candida fungi becoming pathogenic is influenced by: poor oral hygiene, poor-quality fillings and aesthetic restorations made of composite materials and others, prosthetics with removable and non-removable orthopedic and orthodontic structures and devices, constant wearing of various "dental jewelry" such as "grills" and rhinestones in the oral cavity [60, 67].

Under the influence of fungi of the genus Candida, the course of the underlying oral disease is more severe and prolonged, and the symptoms become significantly pronounced, which, according to several authors, considers the influence of yeast-like fungi on the course of mixed infection as a synergy [30, 31, 60, 107]. This statement is illustrated by the situation when, in the presence of fungi of the genus Candida, the resulting periodontitis is accompanied by the presence and long-term preservation of apical foci [30, 31, 60, 107]. But the symptoms of the disease do not always worsen, it can often be observed that the characteristic clinical picture becomes erased and veiled [30, 31, 60, 107]. The authors explain this by the fact that due to the action of pathogenic factors of each pathogen present on each other, the symptoms of the disease caused by different pathogens are leveled and, thus, a "summary" representation of the clinical picture of the disease is created, which makes it difficult to diagnose and plan further treatment [30, 31, 60, 107].

Fungi of the genus Candida have the opportunity not only to influence the clinical course of a particular dental disease, as well as the immunological status, they can change the dynamics of the release of pathogens, which lengthens the time of their stay in the body, thus forming a bacterial carrier [1, 32, 80]

Candida fungi have also been found in the canals of endodontically treated teeth. This fact indicates that Candida is very resistant to modern medications used in endodontics [89, 96, 115, 109, 119].

A good nutrient medium for the growth and development of the vital activity of microorganisms is created by a part of the vital or necrotized pulp, saliva proteins and components of the periodontal tissue fluid [89, 96, 119]. Other microorganisms that are found in the oral cavity have a pathogenic effect on periodontal tissues through secreted ones, damaging them and providing a nutrient medium for a number of pathogens [89, 96, 115, 119]. With incomplete elimination of microorganisms such as Enterococcus faecalis and Candida albicans, inflammatory processes in the periodontium can be maintained for a long time even after treatment [30, 43, 89, 96].

1.5. Traditional methods of endodontic treatment

The main purpose of endodontic treatment is to eliminate infection by removing inflamed and necrotized pulp from the entire root canal system, cleaning the canal walls from infected dentin and giving it an appropriate shape, drug exposure with increased effectiveness of the drugs used, as well as preparing the entire root system (from the mouth to the apical opening) for its subsequent obturation [82].

The general approach to endodontic treatment is based on solving the same tasks as:

- prevention and prevention of the development of a pathological process in periapecal tissues;

- maximum preservation of tooth tissues with subsequent restoration of its anatomical shape through restoration or non-removable orthopedic structure in order to preserve the functional ability of the entire dental system;

- improving the quality of life of patients [74, 82].

Treatment of pulp and periodontal diseases is usually carried out in several stages [122, 126]. The first stage: under local anesthesia, the pulp and its residues are removed, mechanical and drug treatment of the root canals is performed, a suitable shape is given and a temporary therapeutic dressing is applied, followed by closure with a temporary filling [29, 44, 74]. On the second visit: after repeated mechanical and medical treatment of the root canals, they are filled with a permanent material and the crown part of the tooth is restored. According to the clinical recommendations presented by the Dental Association of Russia (DAR), the treatment of diseases of the pulp and periodontitis of the tooth includes the following stages, which are shown in Table 1.

Table 1 - Stages of endodontic treatment

Stage	Explanation
Measures aimed at preserving the viability of the pulp	In the event that such an opportunity is available (depending on the available conditions and the form of pulpitis)
Local anesthesia (in the absence of general contraindications)	Anesthesia of the tooth for subsequent manipulations
Creating access to the tooth cavity	Convenience and visualization of the work field
Opening of the tooth cavity	Removal of infected dentin, visualization of the tooth cavity
Creating direct access to root canals	Trepanation of the tooth cavity, removal of its roof and undercuts, expansion of the mouths of root canals
Pulp removal	Extraction of the pulp in its entirety or its residues from the root canal system
Passage of the root canal	It provides for the achievement of the tip of the root with thin endodontic instruments, primary passive passage and examination of the root canal are carried out
Determining the working length of the root canal	It is carried out for the subsequent determination of the master file and the master pin
Mechanical and medical treatment of the root canals of the tooth	Mechanical removal of infected root canal dentin, followed by its expansion and giving it an appropriate shape for filling
Root canal filling	Creating an airtight root filling
Monitoring using radiation imaging techniques	Mandatory X-ray monitoring at each stage of endodontic treatment
Application of physical methods (according to need)	Application of laser technologies for root canal treatment
Restoration of teeth after endodontic treatment.	Restoration of the lost hard tissues of the tooth with the help of restoration or orthopedic construction

Mechanical treatment of root canals is carried out with manual or machine endodontic tools, or combinations thereof. There are various systems of endodontic instruments that differ in their length, taper, and cutting surface. For the complete removal of infected dentin, drug treatment and obturation of the root canal system, according to clinical recommendations [29], during mechanical treatment it is necessary to obtain a taper of 6-9% [114]. According to the data obtained by S.S.Lim and C.J. Stock [102], if the thickness of the residual dentin reaches 0.3 mm or less, then the chance of developing vertical root cracks increases. A.V. Mitronin et al. [43] in their experiments found that the largest number of microcracks occurs when treating root canals with the Pro Taper system (in 50% of cases), when working with Mtwo files - there are 3 times fewer such complications, and when working with hand tools in the apical part, they are practically not noted [43, 89, 99, 102].

Another important factor that should be taken into account in endodontic treatment is the method of administration of medications. Strong antiseptics are used for root canal irrigation, antiseptically bandages, applications of various mixtures of medicines, calcium-containing preparations [112].

Root canal irrigation is one of the most important stages of endodontic treatment, the purpose of which is to eliminate microbial biofilm from the predentin lining the root canal from the inside [29, 44, 52]. It is customary to use various liquids as irrigation solutions: acid solutions, which include citric acid, lactic acid, tannic acid, polyacrylic acid; enzymes; chelating solutions; natural polysaccharide (for example, 0.2% chitosan); various broad-spectrum antibiotics (for example, tetracyclines), as well as various chlorine compounds (for example, sodium hypochlorite 3% or chlorhexidine 2%) [33, 79, 125]. The most well-known antiseptic for irrigation in dentistry is sodium hypochlorite [79]. It is used in concentrations from 0.5 to 5.25% [79]. Its solution helps to remove organic tissue residues from the treated dentin surfaces, so that sodium hypochlorite has been widely used for antiseptic treatment of root canals [52, 79, 91, 99, 126]. The mechanism of action of sodium hypochlorite is that it acts on fatty acids and

converts them into fatty acid salts (soap) and glycerol (alcohol), thereby reducing the surface tension of the remaining solution [79, 91, 99]. The use of antiseptic solutions affects the growth and vital activity of microorganisms, suppressing it [52, 79, 91, 99]. But sometimes this is not enough. And to enhance the effect of the medicines used, ultrasonic activation of solutions in the channels is used.

At the final stage of endodontic treatment, root canal obturation is performed with permanent filling materials [79, 91, 99, 126]. There are various methods of root canal obturation: lateral condensation, vertical condensation, filling with Thermafill system, filling with one paste, filling with paste using one gutta-percha pin after its pre-packing, depophoresis method [110, 117].

It is generally believed that the purpose of root canal obturation is absolute root hermeticism. At the same time, it is known that an ideal root hermeticism is actually unattainable [70, 117]. Modern root canal filling is based on the use of two components – a filler and a filler. [92, 117, 121]. But currently there is no material or filling method that would meet all the requirements at once, and these are [105, 111]: three-dimensional obturation of the main channel and branch systems, radiopacity [4], inertia of the material, the possibility of easy insertion and extraction of the material, ease of use, accessibility. Permanent obturation of root canals with paste alone is considered an ineffective method, the use of silers and fillers is a more effective method of obturation. Gutta-percha pins are used as a modern filler, and preparations based on epoxy resins are used as a siler [87].

All traditional methods used in endodontics can be conditionally divided into several categories. Among them are conservative and surgical, vital and devital methods, complete removal of the entire tooth pulp (extirpation) and partial removal of the pulp (amputation) [29, 49, 74, 77].

Vital methods include vital extirpation, vital amputation, and the biological method. Devitals include devital amputation and devital extirpation of the tooth pulp [29, 49, 74, 77].

Vital extirpation of the tooth pulp. The purpose of this method is the complete removal of the crown and root pulp of the tooth under local anesthesia, followed by

mechanical and medical treatment of the root canals and their permanent filling. Indications for vital extirpation are all forms of dental pulpitis, both acute and chronic, including traumatic pulpitis, as well as pulpoperiodontitis [9, 29, 44, 49, 74, 75, 77, 78].

The advantage of the vital extirpation method is the possibility for the dentist to eliminate the pain syndrome and carry out all the necessary stages of endodontic treatment in one visit. The disadvantages of this method include a high probability of breaking off a part of the instrument in the root canal during mechanical processing or during pulp extirpation, the development of post-filling pains, the development of complications arising from root canal filling, and the duration of administration.

Many studies have shown that the level of complications arising from endodontic treatment with pulp extirpation exceeds 50% worldwide [9, 29, 44, 49, 74, 75, 77, 78]. In the future, such teeth that have undergone endodontic treatment can become foci of chronic infection and intoxication, which can lead to various somatic diseases of internal organs [9, 29, 44, 49, 74, 75, 77, 78].

Vital amputation of the tooth pulp. The aim of the method is to partially remove the crown pulp of the tooth while preserving the remaining vital root pulp in the root canals. Thus, a biological barrier is formed in the channels for the penetration of microorganisms into the periodontium. A prerequisite for vital amputation is the creation of aseptic conditions during treatment, as well as subsequent hermeticism during tooth restoration. Indications for vital amputation are: acute forms of pulpitis, chronic fibrous and chronic hypertrophic pulpitis, traumatic pulpitis, exacerbation of chronic pulpitis, accidental exposure of the pulp horn, tooth with unformed roots. Contraindications include the severe somatic condition of the patient, the age of more than 30 years, the inability to create aseptic conditions, EOT of more than 40 mkA, the need to use a tooth as a support for an orthopedic structure [9, 29, 44, 49, 74, 75, 77, 78].

Despite the fact that the method is an alternative to vital extirpation in the treatment of pulpitis of multi-root teeth of the adult population and contributes to the preservation of the viability of the root pulp, it has not been widely used due to the

complications that arise against the background of the inability to create "ideally" aseptic conditions during treatment, as well as during restoration, and low effectiveness medicines aimed at eliminating the inflammatory process in the tooth pulp and preserving its viability in the remaining root part [9, 29, 44, 49, 74, 75, 77, 78].

A biological method for the treatment of pulpitis. The purpose of this method is to fully preserve the vitality of the entire tooth pulp. By applying medicines and without mechanical removal of the tooth pulp, the removal of the inflammatory process is eliminated, dentinogenesis is stimulated, thus maintaining a natural barrier against the spread of infection in periodontal tissue [9, 22, 44, 49, 77, 78, 116]. It is carried out according to two schemes – direct and indirect coating of the tooth pulp [9, 22, 44, 49, 77, 78, 116]. The conservative method of treating pulpitis has a strict set of indications. These include:

- age up to 30 years;
- absence of somatic pathologies of the body;
- acute focal pulpitis and chronic fibrous pulpitis;
- - EOT up to 25 μA;
- traumatic pulpitis with exposure of the pulp horn;
- absence of periapical changes on the X-ray;
- orthopedic restoration of the tooth stump is not planned.

If the list of indications is expanded, the use of a biological method for the treatment of pulpitis is not advisable. Also, all patients who have had a biological method of treating pulpitis, especially using them as supporting teeth during orthopedic treatment, must be registered at a dispensary [9, 22, 44, 49, 74, 75, 77, 78].

Devital extirpation of the tooth pulp. The purpose of the method is the complete removal of the tooth pulp after its preliminary devitalization with medications. It helps to eliminate the pain syndrome and prevent the spread of infection in the periodontal tissue. Preparations based on arsenic anhydride or paraformaldehyde are used to necrotize the pulp. To be conducted in several visits

[9, 29, 44, 49, 74, 75, 77, 78]. On the first visit after the opening of the carious cavity and the removal of all pigmented infected hard tissues of the carious cavity, the drug is applied to the opened pulp horn under a temporary filling. On the second visit, the roof of the pulp chamber is removed, the crown pulp is amputated, access is provided to work in the root canals, all root pulp is extracted, followed by mechanical and drug treatment of the root canals and their filling. Indications for devital extirpation of the pulp are: the presence of impenetrable canals, more often the elderly age of patients, obliterated canals, the presence of an allergic reaction to local anesthetics, treatment of pulpitis of temporary and permanent teeth in children, treatment of residual root pulpitis. Contraindications include a severe general somatic picture, intolerance to the components of the devitalizing drug [9, 29, 44, 49, 74, 75, 77, 78].

Devital amputation of the tooth pulp. The purpose of the method is the partial removal of the tooth pulp after its preliminary devitalization with medicinal preparations, followed by impregnation with mummifying agents of the remains of the root pulp. This method is indicated in the case of complete obstruction of channels in multi-root teeth in all forms of pulpitis, as well as in severe patient condition. As a mummifying drug, I often use, for example, resorcinol-a formalin mixture, which is applied to the mouths of channels and then pushed into the mouth with a tool. The root pulp and partially the predentin layer are impregnated with resorcinol-formalin liquid, then polymerization occurs. The tissue turns into a vitreous mass, which is not further decomposed [9, 29, 44, 49, 74, 75, 77, 78].

1.6. Features of endodontic treatment taking into account the detection of mycotic flora

The composition of the microbiota of root canals in chronic gangrenous pulpitis and exacerbation of chronic periodontitis, both qualitative and quantitative, has a direct impact on the approach to treatment and its final result. The key to successful endodontic treatment is to create the most aseptic conditions in the root canals of the tooth, followed by their hermetically filled filling with permanent filling material, as well as to prevent their re-infection, in order to prevent possible complications, for example, the development of apical periodontitis [17, 29, 31, 44].

In Russia, the use of extirpation methods for the treatment of pulpitis is widespread, while insufficient attention is paid to the assessment of the mycotic-bacterial complex of pulp and root canals [9, 29, 44, 49, 74, 77, 78].

Considering the data obtained earlier in the study of the works of Kumirova O.A. (2002), Shumilovich B.R. (2000), Shishkin A.V. (2013) and others, where there is evidence of the presence of yeast-like fungi of the genus Candida in the pulp, dentine, and root canal walls, as well as taking into account the aggravation of processes after COVID transfer-19, they force us to reconsider traditional methods of endodontic treatment [31, 97, 110].

According to studies by Siren E. (2004), E. faecalis and C. albicans are often found in root canals free of medicinal pastes or inhomogenously filled with temporary materials, between visits, when treatment is carried out in a large number of visits (from 2 or more), with repeated endodontic treatment [45, 97, 93]. The presence of these microorganisms leads to the appearance of secondary infection in the root canals: in 77% of cases - E. Faecalis, in 20-25% C. Albicans. Such an observation may be related to the fact that microorganisms in the root canals form biofilms. The existence and functioning of microorganisms in such a structured colony makes them more resistant to various medicines for root canal irrigation and temporary therapeutic dressing [70].

The choice of a drug for root canal irrigation stops at a solution of sodium hypochlorite (NaOCl), a solution of ethylenediaminetetraacetic acid (EDTA), chlorhexidine bigluconate 0.05% or 2%, as well as various enzymes [52, 72, 86, 115]. Studies show the resistance of Candida albicans to antiseptic drugs used in endodontics, if they are in the biofilm of the root canal and synergize with other microorganisms [9, 29, 49, 77, 78, 74, 91].

Sodium hypochlorite is most often used in modern endodontics. It is capable of dissolving organic pulp residues, has high antibacterial and hydrolytic properties, thereby having a significant effect on the biofilm of the root canal, dissolving its organic matrix [8, 52, 72].

EDTA solution affects inorganic compounds in tooth tissues and does not have antimicrobial activity. [36, 52, 72, 103, 115]. That is why it is recommended to use both 2-6% sodium hypochlorite solution and 17% EDTA solution during root canal irrigation. But do not forget that sodium hypochlorite loses its antimicrobial properties in the presence of EDTA solution [36, 52, 103]. Therefore, it is worth avoiding their simultaneous use and carrying out irrigation with distilled water between them [36, 57, 103].

Another antiseptic for root canal irrigation is a solution of chlorhexidine bigluconate. It is a cationic antiseptic that is active against most microorganisms, such as: gram-positive and Gram-negative bacteria, fungi of the genus Candida, lipophilic viruses, Staphylococcus aureus and others [36, 52, 57, 103]. The disadvantage is that it does not have the ability to penetrate deep into the layers of the biofilm matrix of the root canal [58]. At the same time, it has the ability to prevent the growth of the biofilm itself. Regardless of the concentration of the chlorhexidine bigluconate solution, it does not have the ability to dissolve organic compounds in the root canal [8]. Also, at pH values = 8 and above, the activity of this irrigation solution decreases [8, 86].

Various studies have indicated that sodium hypochlorite and chlorhexidine solution have an effect on C.Albicans. But this effect depends on the concentration of solutions and the exposure time. Thus, in a number of reviews, it was noted that

when 3% NaOCl was applied to a biofilm containing C.Albicans for 5 minutes, viable cells were detected [52, 90, 103]. It follows that the vital activity of Candida is associated with the activity of the entire biofilm, so they can be resistant to the antimicrobial effects of sodium hypochlorite, unlike free microorganisms [3, 90, 103].

It is proved that with an increase in the saturation of the NaOCl solution and its exposure time, its antibacterial and proteolytic ability increases [3, 58, 90, 103]. At the same time, exposure to high concentrations of the solution leads to weakening of the walls of the root canals, which makes it difficult to fill the root canals qualitatively due to a significant decrease in the elastic modulus of dentin [47, 81, 115].

In other publications, the effectiveness of exposure to a solution of chlorhexidine 2% and sodium hypochlorite 6% was demonstrated more highly in relation to yeast-like fungi of the genus Candida and allowed to eliminate more of them [90, 103].

Despite the wide choice of various preparations for irrigation of the root canal system, the dentist cannot achieve the effect of sterility [27]. The reasons are: the resistance of some microorganisms to the irrigation solutions used and their partial adaptation to action in subsequent doses; partial neutralization of the properties of the solutions used by the components or products of the vital activity of the microorganisms themselves; the inability of irrigants to penetrate into the lateral branches of the root canals deeply enough; non-compliance with the rules and recommendations for the exposure of drugs by time; insufficient concentration of solutions [27, 52, 101, 115].

Ultrasonic systems are used to improve the quality of root canal irrigation [118]. With the help of an ultrasonic wave, the irrigation solution is activated. Such an effect makes it possible to combine mechanical action and irrigation, as well as chemical and physical effects [86, 101, 124]. Improvement of the results is possible due to the formation of vortex flows around the working part of the instrument and the effect of cavitation when working in the root canal with

ultrasound [101, 124]. This effect allows irrigation solutions to penetrate more deeply into the structure of the root canal, which contributes to the effective removal of dentin chips that block the dentine tubules [60, 101, 119, 124].

According to research by Khorlenko et al. For successful antibacterial treatment of root canals in patients with apical periodontitis, it is recommended to use a combined action of ultrasound and an antimicrobial drug in the form of a gel containing many components such as chlorhexidine 2%, metronidazole benzoate, hydrocortisone [104].

There is also an effective combined method of endodontic treatment proposed by Yasini et al. by the authors, including the use of ultrasound and curcumin [104].

In addition to the use of irrigation solutions and ultrasonic technologies, the use of laser effects has also found wide application [123]. Diode, erbium and erbium-chromium lasers are used in endodontic treatment [45, 52, 60, 84, 98]. The positive property of laser radiation is its antibacterial and anti-inflammatory effect. It also promotes reparative processes [45, 60, 84]. When working with laser technologies, there are a small number of contraindications, limited use of anesthetics and bloodlessness [8, 60, 84, 94]. Laser exposure in endodontic treatment is effective in relation to Streptococcus sanguinis, Enterococcus faecalis and Candida albicans, which antiseptics used according to the irrigation protocol cannot always cope with, as described earlier [8, 52, 60, 84, 94, 115].

For example, according to studies on the effectiveness of root canal disinfection with irrigation of 17% EDTA, as well as with exposure to Er:YAG laser, followed by a microbiological study by Razumova S.N. and co-authors (2019) [53], which was performed on teeth infected with Enterococcus faecalis, Streptococcus sanguinis, and Candida albicans strains, complete sterility of the root canal system [38, 53, 59, 60, 123].

According to studies of the antimicrobial effect of laser radiation, when treating "C-shape" root canals, Mustafa and others, the use of diode laser radiation

effectively reduces the contamination of Candida Albicans in curved root canals [2, 104].

Nevertheless, there is also information about the resistance of some microorganisms to the action of the laser. In 60% of cases, the growth of pathogens Prevotella melaninogenica, Enterococcus faecalis, Bacteroides fragilis was observed [5, 59].

Despite the wide variety of endodontic treatment methods and drugs for influencing representatives of the microflora of root canals, it is not always possible to achieve complete elimination of biofilm during irrigation and medical or physical exposure to them [27]. It is especially important to look for ways to modify treatment against the background of emerging complications after suffering COVID-19. All this served as the basis for determining the purpose and purpose of this work.

CHAPTER 2. MATERIALS AND METHODS OF RESEARCH

The study involved 117 patients with a history of COVID-19 previously transferred at different times, who sought dental treatment at a dental clinic.

To include patients in the study, it was necessary to meet several criteria, which include: confirmed COVID-19 (according to information about COVID-19 diseases from the Gosuslugi portal) and a confirmed diagnosis of "chronic gangrenous pulpitis" and "exacerbation of chronic periodontitis". The final diagnosis was confirmed according to the collected complaints, the data obtained from the main and additional examination methods.

To exclude patients from the study, the criteria were the presence of severe general somatic diseases, the refusal of patients to participate in the study, or the participation of patients in parallel in another study.

Figure 1 shows the design of the dissertation research. All 117 patients undergo basic (collection of complaints, anamnesis, external examination, examination of the cavity and vestibule of the mouth, probing, percussion and palpation) and additional methods (electrodontodiagnostics, X-ray examination, carrying out Green-Vermillion oral hygiene indices, KPU index) diagnostics. Next, the material is collected for laboratory diagnostic methods, which include bacterioscopic examination and bacteriological culture on a nutrient medium, followed by an assessment of colony growth. According to the results obtained, divide the patients into study groups and carry out appropriate treatment.

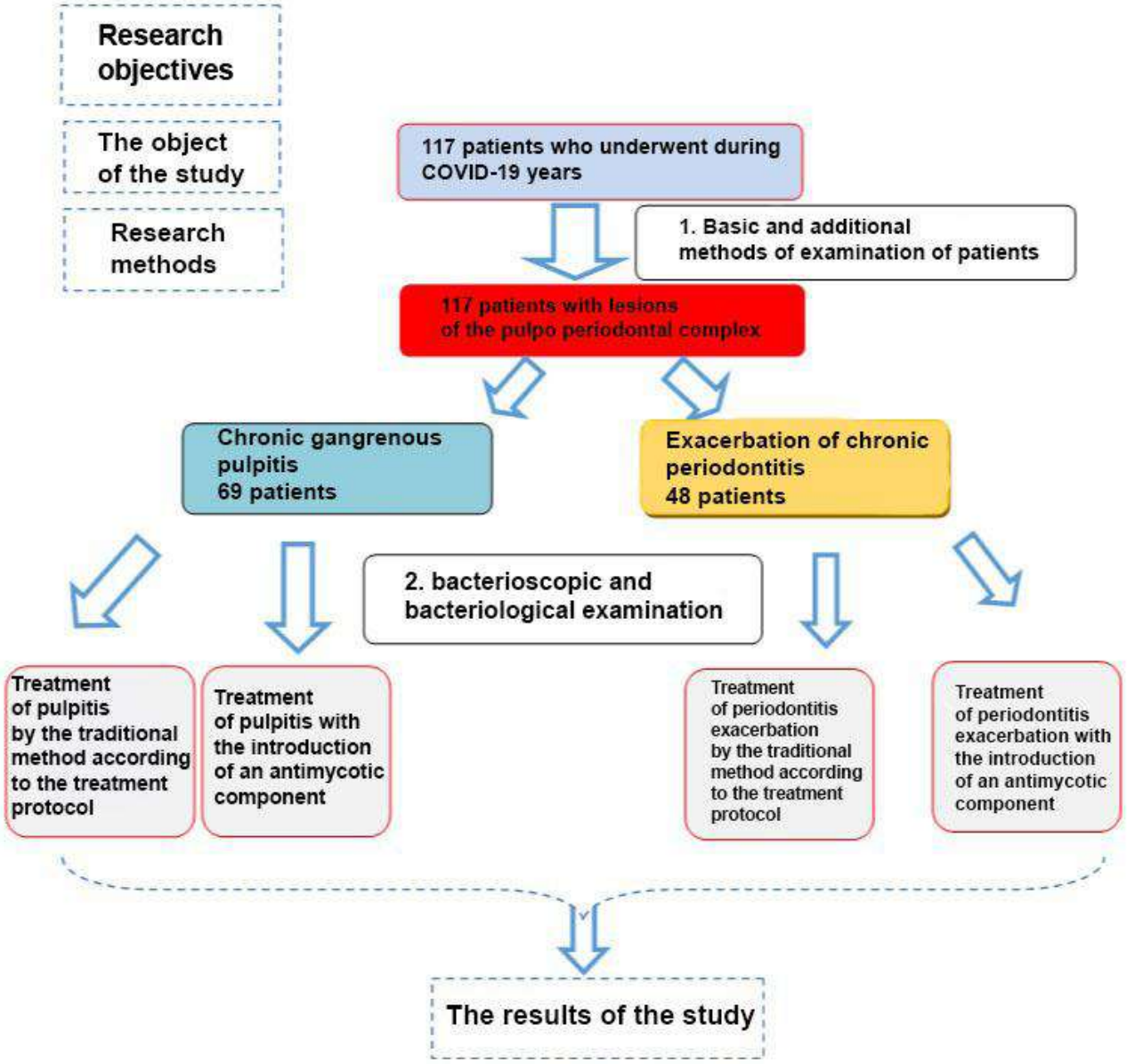

Figure 1. Design of the dissertation research

2.1. General characteristics of patients who had previously been ill with COVID-19 and the conduct of clinical examination methods

The study group consisted of 117 patients aged 21 to 40 years with a history of previous COVID-19 and who sought help at a dental clinic. There were both men and women among the examined patients. The number of men was 54, women - 63.

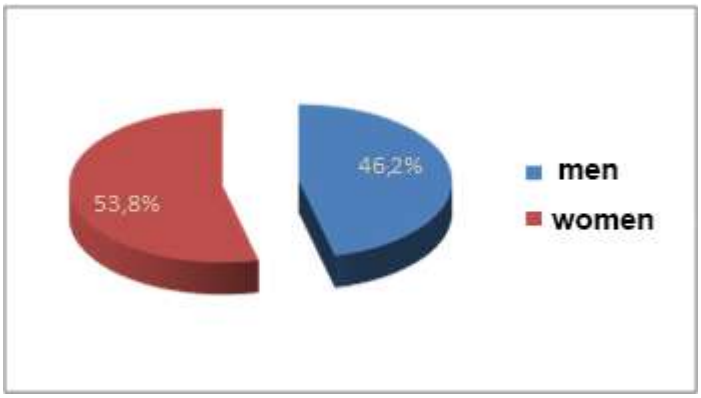

Figure 2. Distribution of the studied patients by gender

The data on the distribution of patients who had previously had COVID-19 by gender and age are presented in table 2.

Table 2 – Distribution of COVID-19 patients, taking into account age and gender

Gender	Age		Total
	21–30	31-40	
	Number of patients	Number of patients	Number of patients
Men	13	36	49
Women	27	41	68
TOTAL	40	77	117

Visualization of data on the distribution of patients who have suffered from COVID-19 disease, taking into account age and gender, is shown in Figure 3. It can be seen from the figure that the samples by gender and age are homogeneous.

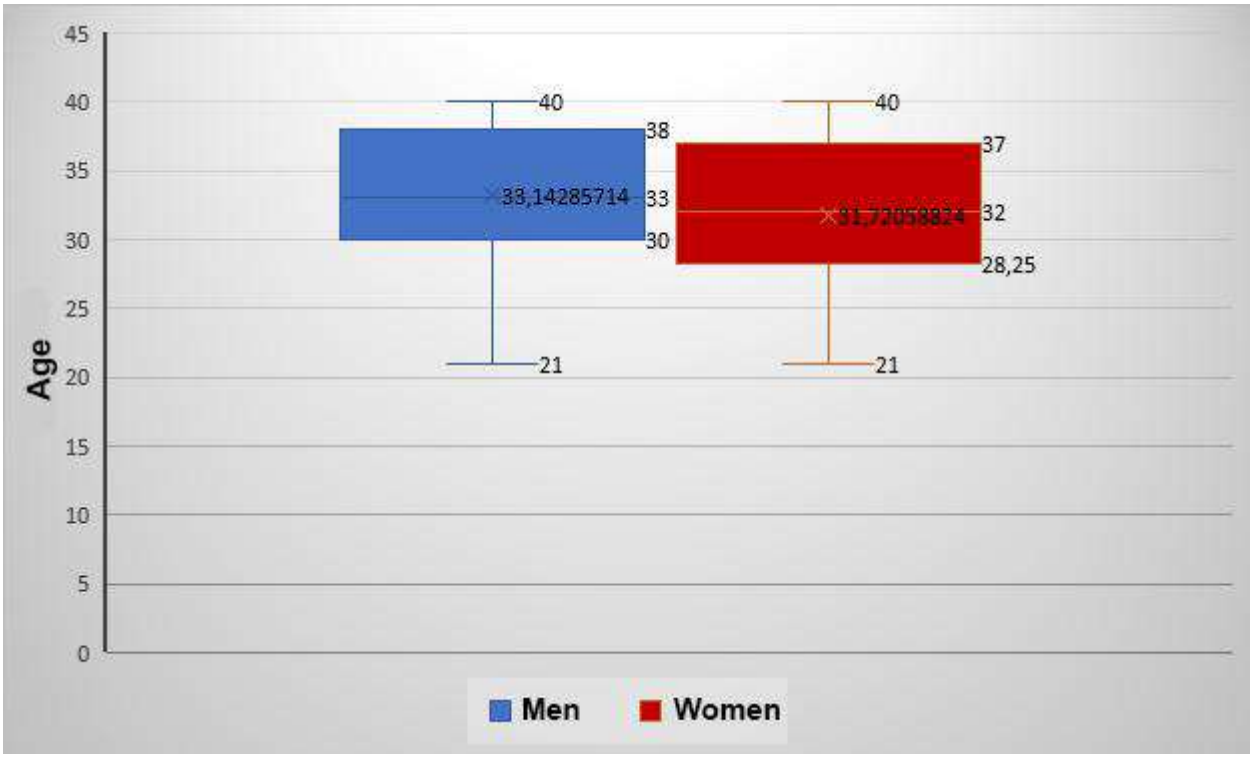

Figure 3. Distribution of COVID-19 patients, taking into account age and gender

Prior to the diagnosis and appropriate treatment, all patients pre-filled out a health questionnaire, where the limitation period for the transfer of a new coronavirus infection was established in the paragraph on the transfer of COVID-19, and voluntary informed consent was signed for diagnosis, X-ray diagnostics, endodontic treatment, bacterioscopic and bacteriological laboratory tests, and the use of the results obtained in this scientific work.

According to the collected data from the survey and the health questionnaire, among the examined patients, all suffered COVID-19. According to the prescription period of the disease, 4 groups can be distinguished: those who were ill 1 month, 3 months, 6 months and 1 year ago.

Table 3 - Distribution of patients, taking into account age, gender and timing of recorded COVID-19

COVID-19 recorder	Age				Total
	21 - 30		31 - 40		
	men	women	men	women	Number of patients
Up to 1 month ago	4	7	6	9	26
Up to 3 months ago	6	6	11	21	44
Up to 6 months ago	2	11	13	9	35
Up to 1 year ago	1	3	6	2	12
TOTAL	13	27	36	41	117

Visualization of the data on the distribution of patients, according to the prescription period of the transmitted disease COVID-19, taking into account age and gender is shown in Figure 4.

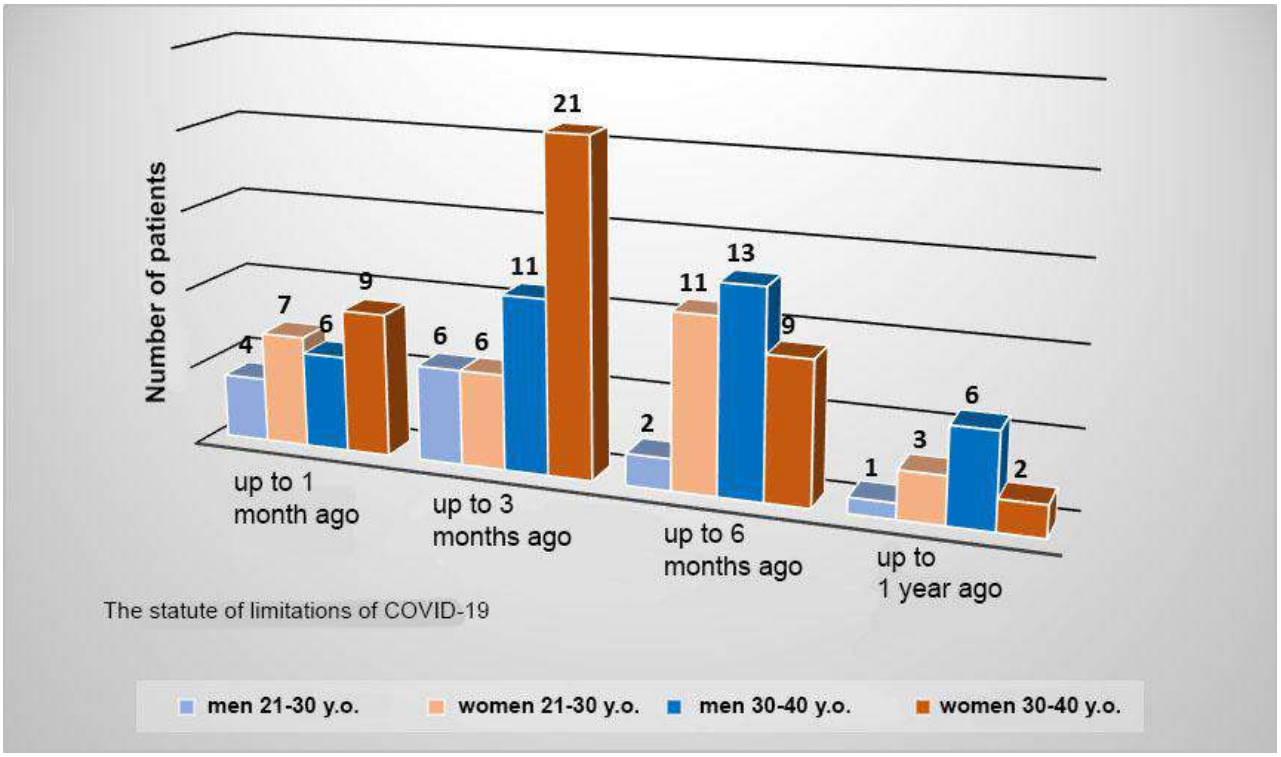

Figure 4. Distribution of patients who underwent COVID-19, taking into account age and gender, and the statute of limitations of COVID-19

In general, the analysis of the study sample showed that the largest category of patients is the group where COVID-19 disease was noted about 3 months ago (Figure 5).

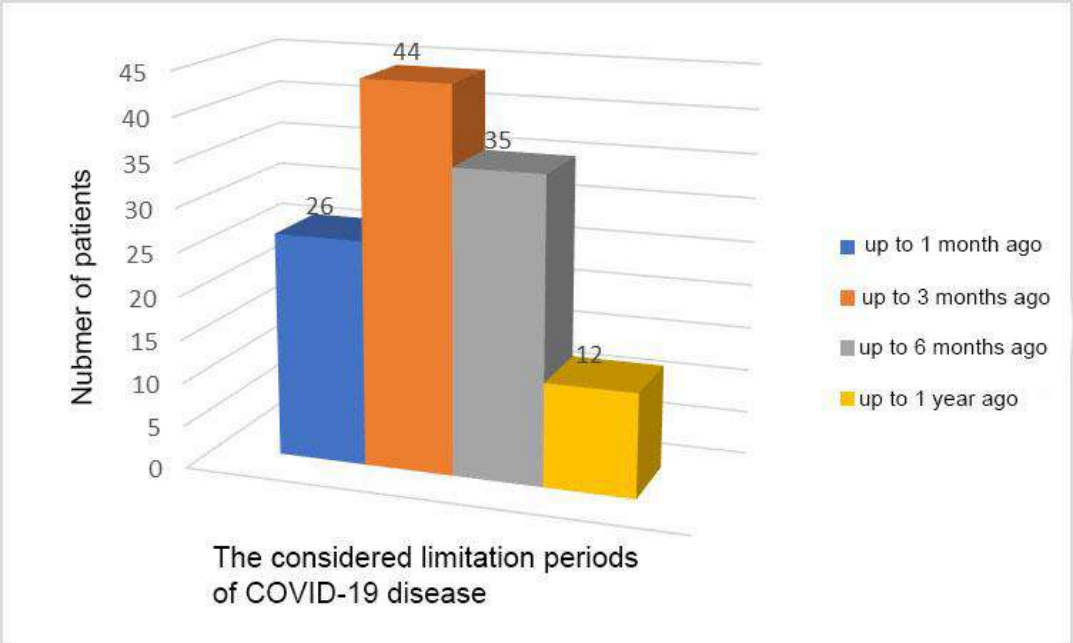

Figure 5. Distribution of patients by prescription period of transmission of COVID-19 disease

The patients were examined according to the standard procedure. A mandatory set of diagnostic measures was carried out for everyone, which included: collecting a life history and anamnesis of the disease (finding out the nature of complaints, when they arose, whether the tooth was treated earlier, about which disease the treatment was carried out), external examination and examination of the oral cavity, probing, thermal testing, percussion, X-ray diagnostics and electrodontometry.

These measures made it possible to diagnose and divide all patients into 2 groups on this basis: patients diagnosed with "chronic gangrenous pulpitis" and "exacerbation of chronic periodontitis".

Of the 117 patients with irreversible changes in the tooth pulp, the final diagnosis was made:

69 (59%) patients – "Chronic gangrenous pulpitis";

48 (41%) patients – "Exacerbation of chronic periodontitis".

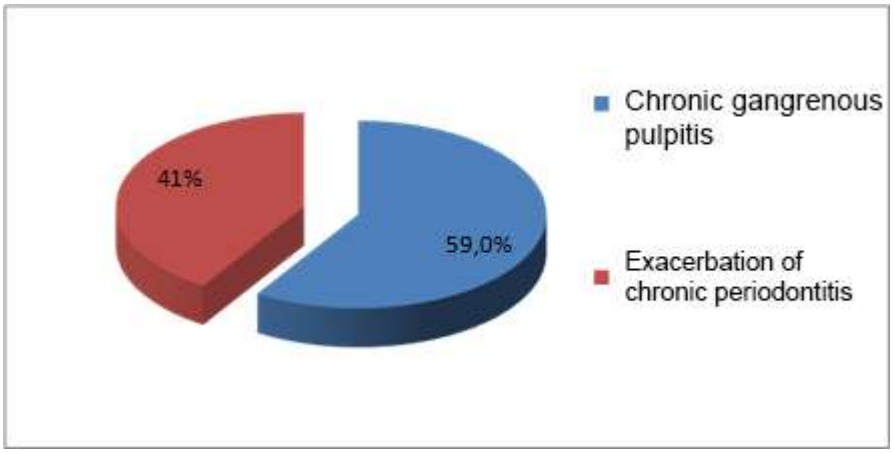

Figure 6. Distribution of patients by type of disease

Table 4 – Distribution of patients by age, gender and diagnosis

Age/gender		Diagnosis of the affected tooth		Total
		Chronic gangrenous pulpitis	Exacerbation of chronic periodontitis	
21-30 y.o.	men	6 (46,2%)	7(53,8%)	13 (100%)
	women	18 (66,7%)	9 (33,3%)	27 (100%)
31-40 y.o.	men	21 (58,3%)	15 (41,7%)	36 (100%)
	women	24 (58,5%)	17 (41,5%)	41 (100%)
Total		69 (59,0%)	48 (41,0%)	117 (100%)

In men aged 21-30 years, chronic gangrenous pulpitis occurs less frequently (46.2%) than exacerbation of chronic periodontitis (53.8%). At the same time,

chronic gangrenous pulpitis was detected in women aged 21-30 years twice as often (66.7%) as exacerbation of chronic periodontitis (33.3%).

When considering the results of the age group from 31 to 40 years, it was revealed that the incidence of chronic gangrenous pulpitis in women is also higher (58.3%) than cases of exacerbation of chronic periodontitis (41.7%). A similar pattern is observed in men, and dental damage with chronic gangrenous pulpitis is 58.5%, and exacerbations of chronic periodontitis are 41.5%.

It is also worth noting that in female patients who have undergone COVID-19, dental pulp and periodontal diseases are more common than similar diseases in males.

Table 5 – Distribution of patients aged 21-30 years by gender and diagnosis

Age/gender		Diagnosis of the affected tooth	
		Chronic gangrenous pulpitis	Exacerbation of chronic periodontitis
21-30 y.o.	Men	6 (25,0%)	7 (43,8%)
	Women	18 (75,0%)	9 (56,2%)
Total		24 (100%)	16 (100%)

According to the data obtained, in women aged 21-30 years, the disease of chronic gangrenous pulpitis is much more common than in males, which is 75.0% of cases. A similar pattern is observed in patients with exacerbation of chronic periodontitis, which is 56.2% of cases in women.

Visualization of the data on the distribution of patients according to the final diagnosis, taking into account age and gender, is shown in Figure 7.

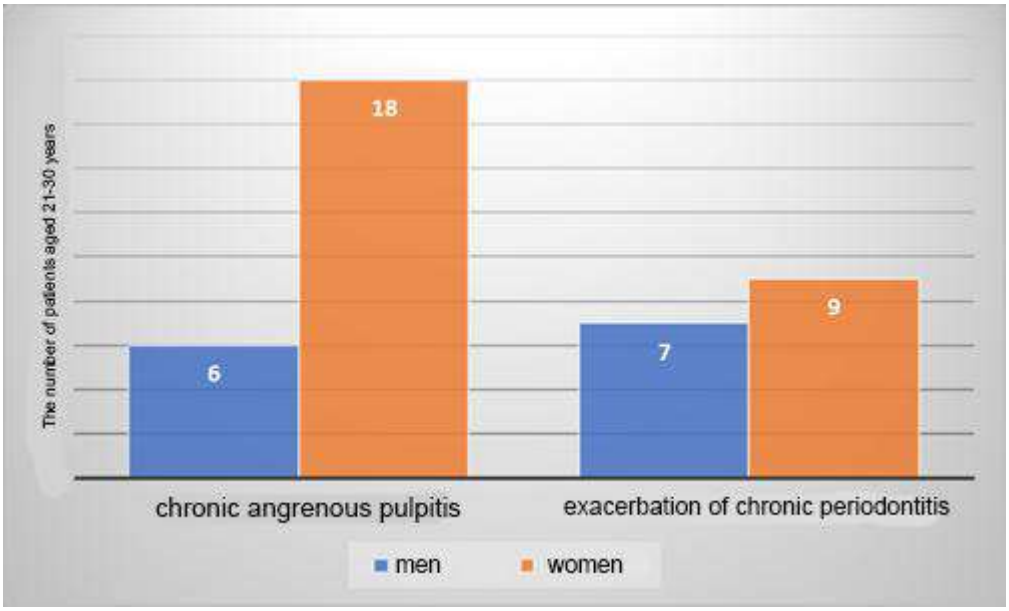

Figure 7. Distribution of COVID-19 patients, taking into account age 21-30 years and gender

Table 6 - Distribution of patients aged 31-40 years by gender and diagnosis

Age/gender		Diagnosis of the affected tooth	
		Chronic gangrenous pulpitis	Exacerbation of chronic periodontitis
31-40 y.o.	Men	21 (46,7%)	17 (53,1%)
	women	24 (53,3%)	15 (46,9%)
Total		45 (100%)	32 (100%)

According to the data obtained, in women aged 31-40 years, the disease of chronic gangrenous pulpitis, as well as in women aged 21-30 years, is slightly more common than in males, which is 53.3% of cases. A different picture is observed in patients diagnosed with exacerbation of chronic periodontitis, where the disease is more common in men, which is 53.1% of cases.

Visualization of data on the distribution of patients by different types of disease, taking into account age and gender, is shown in Figure 8.

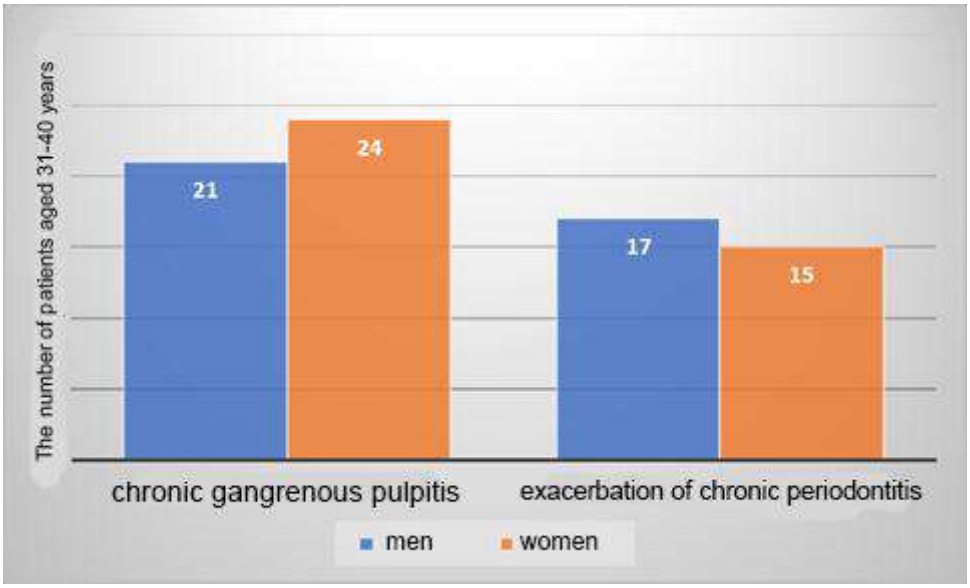

Figure 8. Distribution of COVID-19 patients, taking into account age 31-40 years and gender

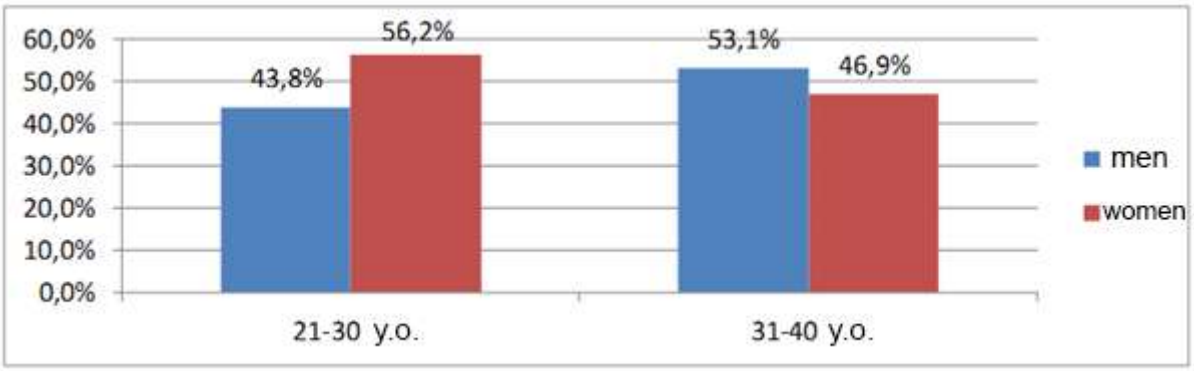

Figure 9. Frequency of exacerbation of chronic periodontitis in men and women by age

In women aged 21 to 30 years, the diagnosis of "chronic gangrenous pulpitis" was observed in 18 (75.0%) patients, much more often than in men of the same age group. There were 24 (53.3%) patients with this pathology in women aged 31-40 years. But at the same time, chronic gangrenous pulpitis in women aged 21 to 30 years is less common than in men aged 31 to 40 years, the number of which was 21 (46.7%).

If we consider the frequency of exacerbation of chronic periodontitis, then this pathology is more common in men aged 31 to 40 years, which was 53.1% than in women of this age group (46.9%) and than in women and men aged 21-30 with the same pathology. This disease is also observed in women aged 21-30 years (56.2%) more often than in men of the same category (43.8%).

The next stage of diagnostic measures is bacterioscopy of the contents of the root canals taken from 117 examined patients to identify mycotic flora in the contents of the pulpoperiodontal complex.

For further investigation, all 117 patients were divided into 4 groups according to the final diagnosis and treatment method:

1) the first group consisted of 36 people, chronic gangrenous pulpitis was detected, traditional endodontic treatment will be carried out according to the protocol and clinical recommendations;

2) the second group consisted of 33 people, chronic gangrenous pulpitis was detected, modified endodontic treatment with the introduction of an antimycotic component will be carried out;

3) the third group consisted of 25 people, an exacerbation of chronic periodontitis was detected, traditional endodontic treatment will be carried out according to the protocol and clinical recommendations;

4) the fourth group consisted of 23 people, an exacerbation of chronic periodontitis was detected, modified endodontic treatment with the introduction of an antimycotic component will be carried out.

The flow chart of patients during the study is shown in Figure 10.

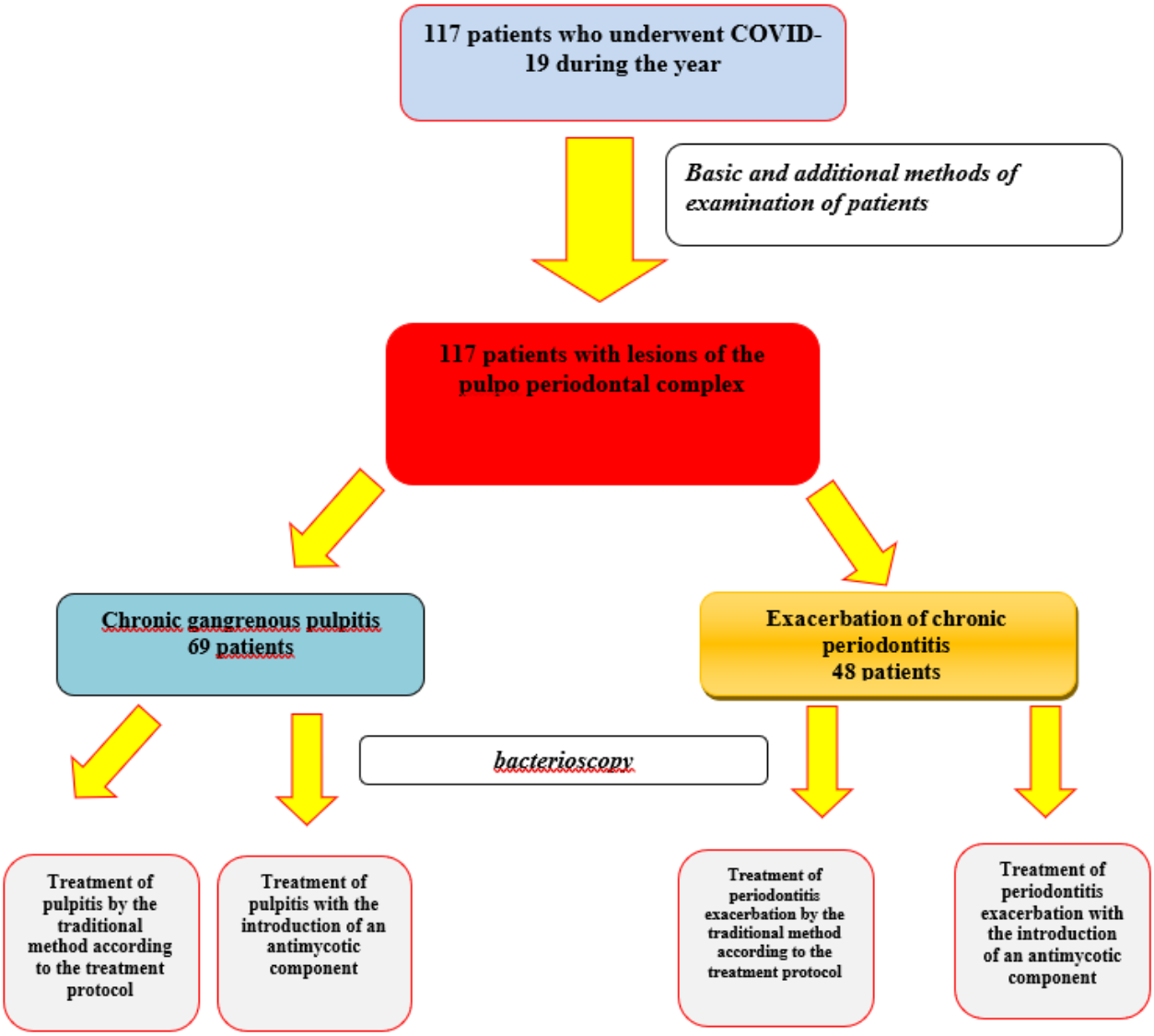

Figure 10. The scheme of movement of patients during the study

After carrying out standard measures, such as anamnesis collection, external examination and oral cavity examination, probing, percussion, thermal tests, radiography and electrodontometry, the final diagnosis was made [20, 24].

The dentist finds out the history of the disease: how long has the patient considered himself sick, what is the reason for the appearance of complaints, the dynamics of the disease, which makes it worse, and what, on the contrary, brings relief, whether the tooth was previously treated and what. The doctor gives the patient a health questionnaire, where it is necessary to specify the diseases that have been transferred, as well as the presence of chronic diseases, injuries and surgeries,

medication intake, allergic status, oncological diseases and possible passage of chemo or radiation therapy. The standard health questionnaire was modified and expanded with an additional block of questions about COVID-19 disease: whether the disease was transferred, when, whether complications for this period, the presence of vaccination.

During an external examination, the configuration of the patient's face was evaluated, the condition of the skin was assessed, the lymph nodes were palpated, and their soreness, size, solidity with surrounding tissues, and consistency were evaluated.

During the examination of the oral cavity, the condition of periodontal tissues and oral mucosa was assessed, the level of hygiene and the nature of the closure of the dentition were determined. The condition of each tooth was assessed (probing, percussion, thermal test, determination of mobility). The results of the examination were recorded in the dental patient's medical record in the dental formula.

All patients were assessed the level of hygiene using the Green-Vermillion index (OHI-S) and the determination of the CFR index.

The Green-Vermillion hygienic index is convenient because it allows you to assess the presence of plaque and tartar separately. For evaluation, a dye can be used, for example, "Fuchsin", "Erythrosine" or a Schiller-Pisarev solution. You can also use just a dental probe. The presence of tartar can be assessed using a probe.

A total of 6 teeth are studied: vestibular surfaces 31, 11, 16, 26, as well as lingual surfaces and 36, 46. The assessment was carried out by calculating the amount of plaque and tartar in the area of the teeth under study.

The value of the raid indicators was summed up and divided into six. The value of tartar was also separately summarized and divided by six. After that, the resulting figures were added up. The resulting value was the hygiene index. Further, the result was to be deciphered according to the scale of values of the hygiene index.

The interpretation of the results obtained is presented in Table 7.

Table 7 - Value of the Green-Vermillion Oral hygiene Index

Value	Assessment of the index	Assessment of oral hygiene
0 – 0,6	Low	Well
0,7 – 1,6	Medium	Satisfactory
1,7 – 2,5	High	Unsatisfactory
>2,6	Very high	Bad

Criteria for assessing plaque based on the surface color of an individual tooth:

0 – missing;

1 - plaque covering up to 1/3 of the tooth plane;

2 – plaque covering up to 2/3;

3 – plaque covering more than 2/3 of the tooth plane.

Criteria for evaluating tartar in an individual tooth:

0 – missing tartar;

1 – supra-gingival dental deposits that cover up to 1/3 of the crown of the tooth;

2 – supra–gingival dental deposits that cover 1/3-2/3 of the crown of the tooth, or there is a subgingival tartar;

3 – supra-gingival dental deposits that cover more than 2/3 of the crown of the tooth, or large subgingival dental deposits located near the neck of the tooth.

Calculation of the Green-Vermillion index using the formula: $OHI - S = \frac{\sum 3H}{n} + \frac{\sum 3K}{n}$,

The CFR indicator clearly reflected the level of intensity of carious processes in one patient with a permanent bite. This is one of the most frequently used indexes in dentistry.

Designations: C – carious tooth lesion, F – filled tooth, R – removed tooth.

The formula for calculating the CFR index:

CFR= sum of values for one person.

The levels of assessment of the intensity of dental caries according to WHO correspond to the following values presented in Table 8:

Table 8 – CFR index value intervals

Value	Assessment
More than 6,5	Very high intensity
4,5 – 6,5	High
2,7 – 4,4	Medium
1,2 – 2,6	Low
0,0 – 1,2	Very low

Determining the value of the CFR index and the level of hygienic condition of the oral cavity allows us to conclude about the role of the microbial factor in the development of the carious process and as a consequence of pulpitis and periodontitis. Since the CFR index reflects the level of resistance to the carious process, as well as the susceptibility to caries, therefore, it shows the condition of the oral cavity in patients who have had COVID-19.

Probing allows you to determine the presence or absence of a carious tooth cavity, assess the condition of the hard tissues of the tooth, the defect or consistency of restoration, or fillings, the presence or absence of a painful reaction, and detect hidden carious cavities. With deep probing of the mouths of the root canals, it made it possible to assess the degree of necrosis of the tooth pulp, which served to differentiate various diseases of the pulp periodontal complex among themselves.

Next, the tooth was percussed. The aim of the study was to make a clinical diagnosis, as well as differential diagnosis of various forms of pulpitis and periodontitis.

During dental percussion, the presence or absence of pain is revealed. It is also possible to determine the intensity of the pain reaction. Horizontal percussion made it possible to assess the condition of the marginal periodontium, while vertical percussion makes it possible to determine the condition of the periapical tissues of the tooth, the presence of cysts or granulomas. Teeth should be percutated from intact teeth, then proceed to the causal tooth. This will allow you to get reliable data.

Percussion was performed by tapping the tooth with the probe handle in the direction of its vertical axis. In addition, the tooth was tapped from different sides to assess the condition of all root surfaces.

Figure 11. Visual examination of a tooth 2.6 with chronic gangrenous pulpitis

Palpation was also used to detect periodontitis, while palpating the gum area in the projection of the apical part of the root. A positive reaction in the form of painful sensations indicated a necrotic pulp.

In cases where the tooth does not respond to temperature tests or EOT, positive percussion and palpation are a sign of apical periodontitis.

Electrodontodiagnostics allows to determine the electrical excitability of the tooth pulp and is carried out with the help of a special device, while determining the states of the nerve elements of the tooth pulp using an electric current. An electrodontometer EOT 1.1 (Aveyron, Russia) was used in the study.

Figure 12. EOT 1.1 device (Aveyron, Russia)

During electrodontodiagnostics, the teeth were previously thoroughly cleaned of dental deposits with a brush on the corner tip, then isolated from saliva and dried. The passive electrode was fixed with a "mouthpiece" on the opposite side in contact with the cheek mucosa.

The study was conducted in several different locations, in 4-5. We were guided by the reaction from the pulp to the minimum current strength obtained at any point.

Table 9 - Electroodontometry data

The value of diagnostic current, mkA	Diagnosis	An increase in EOT values relative to the physiological norm
2-6	An intact tooth	-
7-14	Caries	2-3 times
15-19	Deep caries	3-4 times
20-40	Pulpites	4-5 times
60-100	Necrosis of the root pulp	5-6 times
101-200/no reaction	Periodontitis	More than 6 times

When conducting electrodontodiagnostics, it should be borne in mind that its results may depend on a number of factors, such as age, psychological condition, excitability of the patient's nervous system, features of the structure of the root canal system and the size of the tooth itself, compliance with the recommendations and rules of use of the device, presence in the pulp chamber [23].

Among the additional examination methods, X-ray diagnostics were further used. Orthopantomography was prescribed and performed in 117 patients in order to identify foci of chronic odontogenic infection. It was also possible to determine the dental status of the patient based on the received orthopantomograms. In addition, for a more detailed study of a particular tooth, a sighting image was assigned.

Figure 13. Orthopantomogram of patient V., who underwent COVID-19

Intraoral targeted radiography was also used at all necessary stages of endodontic dental treatment (determination of the working length, packing of the master pin, assessment of the quality of the final filling of the canal, dynamics of treatment of periapical changes).

Figure 14. Targeted X-ray of the tooth 2.6

X-ray examination contributed to the differentiation of various forms of inflammatory diseases of the pulp and periodontium. The structure of the root canals was also evaluated using targeted radiography.

Targeted X-ray images were obtained using a radiovisiograph, which, perceiving X-rays, converts them into a digital format, displaying the resulting image on a computer monitor. Thus, the radiation load is reduced due to the non-use of the film. At the same time, the X-ray images obtained can be stored in the electronic database of the dental clinic for a long time.

2.2. Methods of laboratory examination of the contents of the root canal system of teeth (bacterioscopic and bacteriological)

Special research methods were applied – bacterioscopic and bacteriological study of the microbial composition of the pulpoperiodontal complex.

Each patient gave consent, which was formalized in the form of informed consent to take material for special research methods (smear-imprint for bacterioscopic examination and for subsequent bacteriological examination), they were fully informed and agreed with the treatment plan and possible complications.

The first stage of laboratory diagnostics was a microscopic examination of the preparations of the contents of the pulpoperiodontal complex of the tooth. This method was chosen as a simple, accessible method for detecting elements of fungi of the genus Candida in the collected material.

Despite the fact that the pulp is poor in cellular elements, it was important to identify its inflammation by the state of the cellular elements during microscopy.

The material for bacterioscopic studies were smears, which were viewed under magnification using a Biomed microscope (Figure 15).

Figure 15. Microscope for bacterioscopy "Biomed"

To conduct a bacterioscopic examination, the contents of the root canal were taken with a sterile endodontic instrument. Next, the mass was carefully distributed evenly over the surface of the slide in a thin layer, then staining with 1% aqueous solution of hematoxylin eosin was performed for 15-30 seconds [20, 24]. Next, the dye was washed off with running water, dried and examined with a microscope at a magnification of 7× 90 according to the method of A.A. Kunin (1973) [20, 24]. In the course of the work, the number of elements of fungi and coccal flora in the field of view was determined: single elements or clusters, a lot in the field of view, little or completely covering the entire field of view.

Coloring of drugs is necessary for a number of reasons:

1. it is recommended to carry out in all cases in the presence of fungal microflora;

2. if there are a lot of leukocytes and erythrocytes in the preparation, they can simulate the spores of a fungus of the genus Candida;

3. it will help with a small amount of material;

4. Allows you to store drugs for a longer time.

Next, a bacteriological study was carried out, which consisted in sowing the material on a dense nutrient medium. The data obtained will allow us to confirm and concretize the previously obtained bacterioscopy results.

The material for bacteriological examination was taken during mechanical treatment of root canals with a sterile endodontic instrument. Next, the collected material was placed in a test tube with an Amies Transport Medium, shown in Figure 16. This transport medium is a modification of the basic Stuart transport medium, which is capable of supporting microorganisms such as Neisseria sp., Haemophius sp., Corynebacteria, Streptococci, Enterobacteriaceae, etc., including Candida, for up to 3 days, however, it is recommended to carry out sowing during the first 24 hours in order to obtain the best result hours.

Figure 16. Test tube with Amies transport medium

Next, the material was transported to the laboratory for the purpose of sowing on a nutrient medium. The material was seeded in sterile Petri dishes, and Saburo glucose-peptone agar was used as a dense nutrient medium. The material was rubbed into the agar using a plastic spatula. Next, Petri dishes were placed in a thermostat, incubated for 24-48 hours at a temperature of 37 ± 10 C. Further, the study was carried out according to the generally accepted standard scheme: the obtained cultures were visually identified to the species by the nature of growth in a dense medium [21].

The composition of the Saburo medium is represented by fermented peptone, glucose, casein, and agar. Due to the high concentration of glucose as a component and the low pH level, this nutrient medium exhibits selective properties in relation to fungi. Potassium tellurite is also present in the medium we used, which stains Candida Albicans colonies black instead of the usual white [21].

The principle of the bacteriological research method is the visual detection of bacteria that have grown on the nutrient medium during sowing of the studied samples.

The first study was conducted after 48 hours, and on the 5th day the obtained cultures were finally characterized.

Bacterioscopic and bacteriological examination of the contents of the pulpoperiodontal complex of teeth was performed in patients of all groups before the main stages of endodontic treatment. Also, repeated bacteriological examination was performed before permanent filling.

2.3. Evaluation of the effectiveness of drugs on the identified fungal flora of the contents of the root canals of the tooth

The effect of the drugs was evaluated in the laboratory on 42 Saburo nutrient media with grown fungi of the genus Candida albicans isolated from inflamed pulp in patients with chronic gangrenous pulpitis and the contents of root canals in patients with acute purulent and exacerbation of chronic periodontitis.

The disco diffusion method was used to determine the sensitivity of fungi to antifungal drugs. It is based on the determination of sensitivity based on the ability of antibacterial drugs to diffuse from the disks impregnated with them into the nutrient medium, inhibiting the growth of microorganisms sown on the surface of the agar. Antifungal drugs were used: "Nystatin", "Amphotericin B", "Fluconazole", "Clotrimazole", "Itraconazole" and "Ketoconazole".

Discs with the drugs "Nystatin", "Amphotericin B" and "Fluconazole", "Clotrimazole", "Itraconazole" and "Ketoconazole", designed to determine the sensitivity of yeast-like fungi of the genus Candida to them, were stored in tightly closed vials in a dry place protected from light at a temperature no higher than 2-60C. Saburo agar was used. An important condition for the disco-diffuse method is the thickness of the agar layer in the Petri dish, which should be 4.0 ± 0.5 mm and its application on a flat horizontal surface. Compliance with the above conditions is necessary due to the fact that the size and shape of the microbial growth suppression zone depends on the depth of uniformity of the agar layer.

To determine the sensitivity of yeast-like fungi of the genus Candida to antimycotic drugs, a culture suspension was prepared in an isotonic sodium chloride solution. About 1-2 ml of the suspension was applied to the surface with a nutrient medium in a Petri dish using a pipette and the suspension was evenly distributed over the entire surface by swinging the cup. The excess medium was removed with a pipette and the slightly opened cups were dried at room temperature for about 15 minutes. Discs of two pieces with different preparations were applied at an equal distance of 15-20 mm from each other and left for 1-2 hours. After that, they were

transferred to a thermostat and incubated at a temperature of + 350C for 24 hours. In case of poor growth of the culture, incubation was extended to 48 hours.

Registration and interpretation of the results were carried out according to the diameter (mm) of culture growth suppression. The data obtained were compared with the indicators presented in Table 10.

Table 10 - Indicators of the diameter (mm) of the suppression of the growth of culture of antifungal drugs

Medication	Stable	Sensitive
Amphotericin B	<14mm	≥14 mm
Nystatin	<18 mm	≥18 mm
Fluconazole	<14 mm	≥19 mm
Clotrimazole	<12 mm	≥12 mm
Itraconazole	<13 mm	≥19 mm
Ketoconazole	<19 mm	≥26 mm

The same Saburo medium with fungi of the genus Candida albicans served to determine the minimum suppressive concentration of the most effective antifungal drug using an E-test, for which strips of filter paper impregnated with different concentrations of drugs were used, each of these zones had the appropriate labeling. The strips were placed on the surface of the nutrient medium.

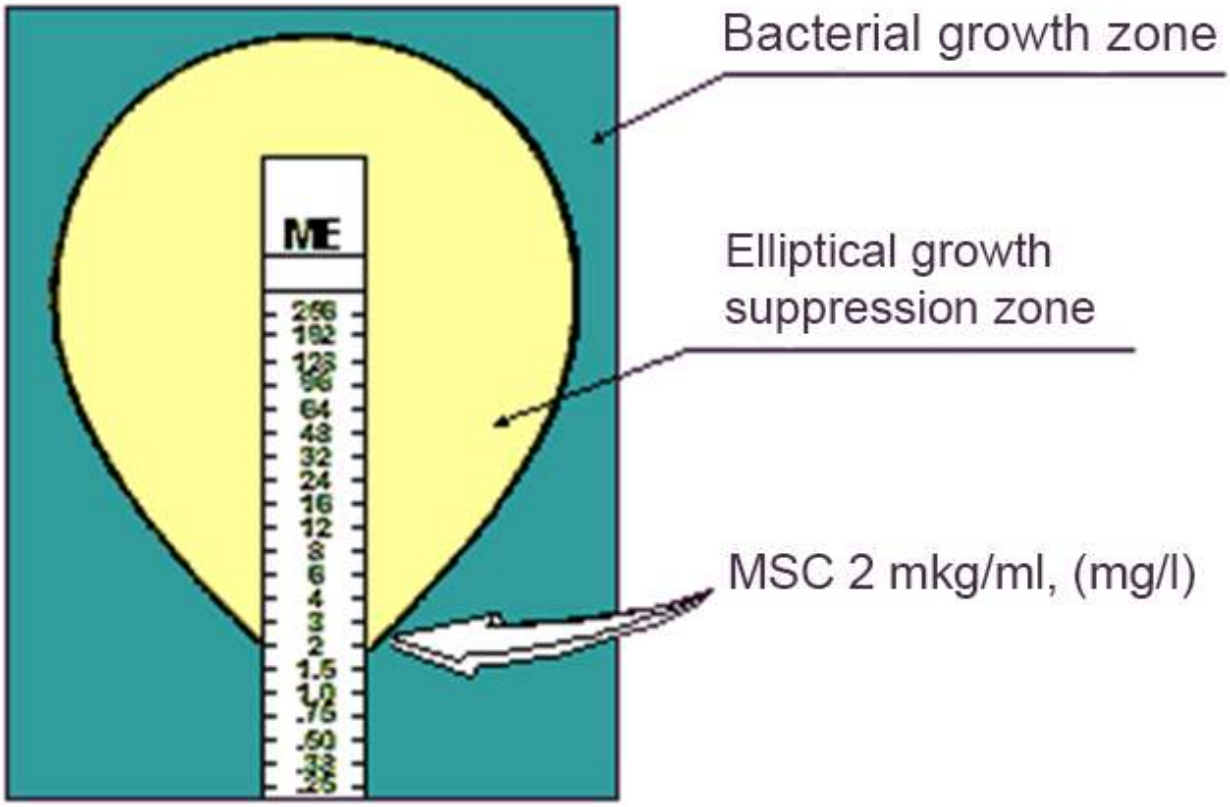

Figure 17. Determination of the minimum suppressive concentration (MSC) of an antifungal drug

If the mushrooms are sensitive to the action of the drug, an elliptical zone was formed around the areas of the strip containing its inhibitory concentrations. Its form is due to the action of several concentrations of the drug at once. The minimum suppressive concentration corresponded to the section of the strip where it is crossed by the boundary of the zone of growth retardation of the colony of fungi [11].

2.4. A method of endodontic suspension treatment using an antifungal component

For further investigation, the patients were divided into four groups according to diagnosis and treatment method:

1) the first group consisted of 36 people, chronic gangrenous pulpitis was detected, traditional endodontic treatment will be carried out according to the protocol and clinical recommendations;

2) the second group consisted of 33 people, chronic gangrenous pulpitis was detected, modified endodontic treatment with the introduction of an antimycotic component will be carried out;

3) the third group consisted of 25 people, an exacerbation of chronic periodontitis was detected, traditional endodontic treatment will be carried out according to the protocol and clinical recommendations;

4) the fourth group consisted of 23 people, an exacerbation of chronic periodontitis was detected, modified endodontic treatment with the introduction of an antimycotic component will be carried out.

In the first group, consisting of 36 people who have chronic gangrenous pulpitis, and the third group, consisting of 25 people who have an exacerbation of chronic periodontitis, traditional endodontic treatment will be carried out according to the protocol and clinical recommendations. The treatment will be carried out according to the following scheme in several stages:

The first visit. Local anesthesia (conduction or infiltration) is performed. Local anesthetics such as Ultracain D-S Forte, Ubistesin Forte 4% were used if there were no contraindications.

Next, we create conditions that are close to sterile. During operation, oral fluid is not allowed to enter the cavity. To create more comfortable working conditions, a cofferdam is used (Figure 18).

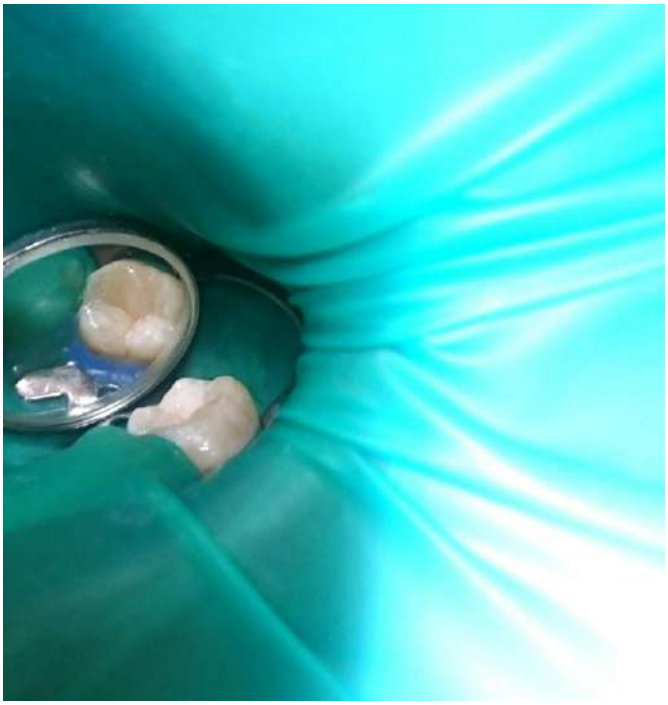

Figure 18. Isolation of the working field, imposition of a coffee pot

Next, the carious cavity is prepared, or the defective fill is mechanically removed using a turbine tip and an angular tip on a micromotor, as well as diamond and carbide burs of a certain size and shape of the working part. Convenient access to the mouths of the root canals is created through the occlusal surface of the molars and premolars, as well as the palatine or lingual surface of the teeth of the frontal group.

Next, the stage of mechanical treatment of the root canal of the tooth with the help of tools. We used the Step Back technique. At first, we worked with hand tools - K-files and H-files. With the help of these tools, the stage of passing and expanding the root canals to a file of 25-30 ISO size was performed. Next, machine tools were used on the endomotor in order to further expand the root canal and make it cone-shaped. Protaper Universal (Dentsplay), shown in Figure 19, was used as machine tools.

Figure 19. Protaper Universal (Dentsply) Tools

Each step of the mechanical treatment of the canal is accompanied by medication according to the irrigation protocol, which includes sodium hypochlorite 3%, distilled water, EDTA solution 17% and chlorhexidine 2%.

Figure 20. The mouth of the root canals

The determination of the working length of the root canals was carried out using an apexlocator and a control sighting X-ray.

Figure 21. A targeted X-ray image to control the determination of the length of the root canal

Next, the root canals are dried using paper pins of the appropriate size. With the help of a channel filler on the corner tip, the calcium-containing preparation Calasept (Nordiska Dental) is introduced into the root canals for a period of 2 to 4 weeks. The mouths of the root canals are closed with Teflon tape, then a temporary fill is hermetically installed into the tooth cavity from dental glass ionomer cement Stomafil (Stomachim).

The second visit. Re-isolation of the working field using a cofferdam. The temporary fill is removed, the Calasept drug is mechanically and medicinally extracted from the root canals. In the absence of complaints, in the absence of a detectable odor from the root canals, a targeted X-ray is taken, a complete irrigation protocol is carried out, the root canals are dried with paper pins and filled with gutta-percha and siler by lateral condensation. The crown part of the tooth is restored with a filling material or sent to an orthopedic dentist for subsequent rational prosthetics.

Figure 22. The final stage of endodontic treatment

In case of detection of fluid, odor in the root canals, with positive vertical and horizontal percussion of the tooth, as well as in the presence of complaints of pain on the part of the patient, the second stage of endodontic treatment became intermediate, and temporary calcium-based material was re-introduced into the root canals, followed by closing with a temporary filling of the tooth cavity.

Thus, the final stage of endodontic treatment was carried out only after eliminating all of the above points.

Figure 23. X-ray quality control of filled gutta-percha root canals

For the other two groups (groups 2 and 4), treatment was also carried out in stages according to the clinical protocol, but in addition to the standard approach, antimycotic treatment was introduced.

The first visit is carried out in the same way as in the first and third groups, but instead of introducing a calcium-based drug into the root canals, an antimycotic drug is topically administered. After the root canal is prepared and dried with paper pins, they begin to create a suspension based on the drug "Fluconazole" for temporary exposure [56]. To do this, 50 mg powder from the capsule is poured onto a sterile glass for mixing the filling material, 1 ml of water for injection is added next to it, the components are mixed with a sterile spatula to create a suspension [56]. After that, a paper pin of the appropriate size is impregnated with the resulting suspension and placed into the previously prepared root canal. Next, the mouth of the canal is closed with a Teflon tape, then the tooth cavity is hermetically filled with a temporary fill made of an impermeable material - glass ionomer cement Stomafil (Stomachim). The exposure of the drug is carried out within 1-3 days, depending on the anatomical structure of the root canal system. The patient is also prescribed the drug "Fluconazole" inside 1 capsule of 150 mg on the first day [56].

After an appropriate period of time, the second stage of endodontic treatment is carried out, in the absence of exudate or odor in the root canal, it is filled with a permanent material using silers and gutta-percha pins. Next, the restoration of the crown part of the tooth is performed with a permanent fill or an appropriate orthopedic structure.

2.5. Methods of statistical processing of results

Many statistical methods were used in the work, and their calculations were carried out in the Statistica program.

The Mann-Whitney criterion. This is a statistical test that is used to compare two independent samples. It allows you to test the hypothesis that two samples are taken from the same distribution or from different distributions.

In the dissertation work, the Mann-Whitney criterion was used to solve the following problems:

• comparison of the results of the experimental groups before and after treatment.

• evaluation of the effectiveness of the new method in comparison with the existing one.

• identification of differences between groups of subjects (for example, by age, gender and other criteria).

The use of the Mann-Whitney criterion in the dissertation work allows us to draw reasonable conclusions about the significance of differences between samples and confirm or refute the hypotheses of the study.

The algorithm of the Mann-Whitney test in the Statistica program:

1. Open the Statistica program and select the "Analysis" tab.
2. In the "Nonparametric tests" section, select "Comparison of two independent groups".
3. Enter the data for each group in the appropriate fields.
4. Select the variables to compare.
5. Click OK or Run to start the analysis.
6. After the analysis is completed, the program outputs the results, including the value of the U criterion, the p-value and other statistical indicators.
7. Based on the results obtained, we conclude that the differences between the samples are significant. If the p-value is less than the selected significance

level, then the differences between the samples are significant. Otherwise, the differences are insignificant.

It is also worth considering that the Mann-Whitney test is a nonparametric method of comparing two groups. It is used when the data does not correspond to a normal distribution or when the variances in the groups vary greatly. The test is based on ranking the values in each group and comparing the sum of the ranks to determine the statistical significance of the difference between the groups.

The Kraskel-Wallis criterion. It is a nonparametric statistical test that is used to compare three or more independent samples. It allows you to test the hypothesis that all samples are taken from the same distribution or from different distributions.

In the dissertation work, the Kraskel-Wallis criterion was used to solve the following tasks:

• comparison of the results of experimental groups before and after exposure (for example, before and after treatment).

• evaluation of the effectiveness of the new method in comparison with the existing one.

• identification of differences between groups of subjects (for example, by age, gender and other criteria).

The use of the Kraskel–Wallis criterion in the dissertation work allows us to draw reasonable conclusions about the significance of differences between samples and confirm or refute the hypotheses of the study.

The algorithm for conducting the Kraskel-Wallis test requires the following steps:

1. Open the Statistica program.
2. Select the "Nonparametric statistics" item in the "Analysis" menu.
3. In the window that opens, select "Compare multiple groups" and click "OK".
4. In the window that appears, set the analysis parameters: specify variables for each group, select a comparison method (in this case, the Kraskel—Wallis criterion) and set the significance level.
5. Click the "Run" button to start the analysis.

After the analysis is completed, the program outputs the results, including the value of the H criterion, the p-value and other statistical indicators.

Based on the results obtained, it can be concluded that the differences between the samples are significant. If the p-value is less than the selected significance level, then the differences between the samples are significant. Otherwise, the differences are insignificant.

Cluster analysis. It is a method used to group objects or observations into different clusters based on their similarity. The purpose of cluster analysis is to divide data into groups so that objects within one cluster are more similar to each other than to objects from other clusters.

This method is widely used in medicine (for the classification of diseases, drugs and other indicators). Cluster analysis can be used to identify hidden structures and patterns in data, which makes it a powerful tool for conducting cluster analysis in the Statistica program, the following steps must be performed:

1. Data preparation and selection of clustering method. Several clustering methods are available in Statistica.
2. Setting the parameters. Each clustering method has its own parameters that can be configured. For example, for the k-means method, you can set the number of clusters.
3. After setting up the parameters, run the analysis. Statistica automatically perform data clustering based on the selected method.
4. After the analysis, we interpret the clustering results.
5. Visualization of the results. Statistica allows you to visualize the results of clustering using various graphs and diagrams.
6. Analysis of the results. Based on the results obtained, we draw conclusions about the data structure and possible patterns. Cluster analysis can help identify hidden groups of objects or patterns in the data.

CHAPTER 3. RESEARCH RESULTS AND THEIR DISCUSSION

3.1 . Results of clinical examination methods

We examined 117 teeth in patients who had suffered COVID-19 in the past using a complex of clinical and laboratory methods, identified 4 groups subject to endodontic treatment of chronic gangrenous pulpitis, exacerbation of chronic periodontitis by traditional methods, according to the protocol of endodontic treatment, and treatment with the introduction of an antimycotic component at an intermediate stage [20, 24].

Any disease is characterized by a set of symptoms that the patient can complain about. These symptoms affect the patient's quality of life to one degree or another.

The clinic was visited by patients who had previously suffered a new coronavirus infection with various complaints, among which were complaints of frequent aching spontaneous pains that arose from temperature and mechanical stimuli, but more often when eating hot food. Patients also note that such pains had never been observed before the transfer of COVID-19. In addition, some patients noted that the pain was observed much earlier, after which the patient independently stopped the pain process by taking painkillers, did not immediately go to dentistry [20, 24].

The clinical characteristics of the complaints presented by patients at the initial request for dental care in accordance with the diagnosis are presented in Table 11.

Table 11 - Clinical characteristics of patient complaints during initial treatment at a dental clinic

Disease	The nature of the complaints			
	Spontaneous aching pains	Pain from thermal stimuli, pain from hot	Pain when biting on a tooth	Irradiating pain
Chronic gangrenous pulpitis	69 (100%)	61 (88,4%)	13 (18,9%)	- (0%)
Exacerbation of chronic periodontitis	- (0%)	- (0%)	48 (100%)	9 (42,9%)
Total	69 (59,0%)	61 (52,1%)	61 (52,1%)	9 (7,7%)

Table 11 shows that out of 117 patients complained of: spontaneous aching pains (59.0%); pain arising from thermal stimuli mainly from hot (52.1%); pain arising from chewing, biting on a tooth (52.1%); irradiating pain along the branches of the trigeminal nerve, due to what makes it difficult to determine the causal tooth (7,7%) [20, 24].

These data correspond to well-known complaints characteristic of the clinical picture of chronic gangrenous pulpitis, exacerbation of chronic periodontitis. But it is worth noting that this diagnostic method is subjective, since the data is obtained from the words of the patient. Also, it is worth noting that the complaints in some cases were "blurred", and corresponded to several nosological forms of lesions of the tooth pulp and periodontium. It can be assumed that such a picture arose in patients due to previously transferred COVID-19 [20, 24].

During the examination of the oral cavity and probing of the causal teeth, 73 (62.4%) patients revealed deep carious cavities on the chewing, lateral (medial and distal) surfaces of the teeth, which were filled with softened pigmented dentin. In this case, probing was more often painless, or painful in the case of probing in the area of the mouths of the root canals.

In a number of cases, which amounted to 23 cases (19.7%), extensive old, untenable fillings were revealed during examination and probing, which were made of composite or dental cement.

In addition, in 27 patients, which accounted for 23.1% of cases, the causal teeth did not have carious cavities or previously installed fillings. Of these, 14 (51.9%) people were diagnosed with discoloration of the crown of the tooth, darkening, clouding.

Probing of the dental cavity in 85 (72.7%) patients is painless, or painful (27.3%) when conducting deep probing in the area of the mouth of the root canals. Percussion of the causal tooth in 69 patients is weakly positive, which is 59%. Percussion was negative in 46 patients (41%). And the indicators of the thermal test demonstrated a reaction to a hot stimulus in 65 (55.6%) patients. Negative results were reported in 52 patients (44.4%).

The results of the main survey methods are shown in table 12.

Table 12 - Data from an objective examination of patients who underwent COVID-19

Characteristics of patients	Probing		Percussion		Thermal test	
	Painful	Painless	Painful	Painless	Positive	Negative
Chronic gangrenous pulpitis	32	37	21	48	65	4
Exacerbation of chronic periodontitis	-	48	48	-	-	48
Total	32	85	69	46	65	52

When studying the etiology and pathogenesis of pulpitis and periodontitis of teeth, the relationship of the CSR index with the course of the carious process was traced using the example of the examined patients who had COVID-19. The data obtained are shown in table 13.

Table 13 - CSR value in the examined patients who had previously had COVID-19

CSR value	up to 6 (compensated form of caries)	from 7 to 9 (subcompensated form of caries)	over 9 (decompensated form of caries)	Total
Количество пациентов	19 (16,2%)	67 (57,3%)	31 (26,5%)	117 (100%)

It follows from the presented table 13 that pulp and periodontal diseases are mainly observed with a high CSR index value (from 7 or more), which is 98 patients – 83.8%.

Visualization of the data on the distribution of CSR values in the examined patients who had previously been ill with COVID-19 is shown in Figure 24.

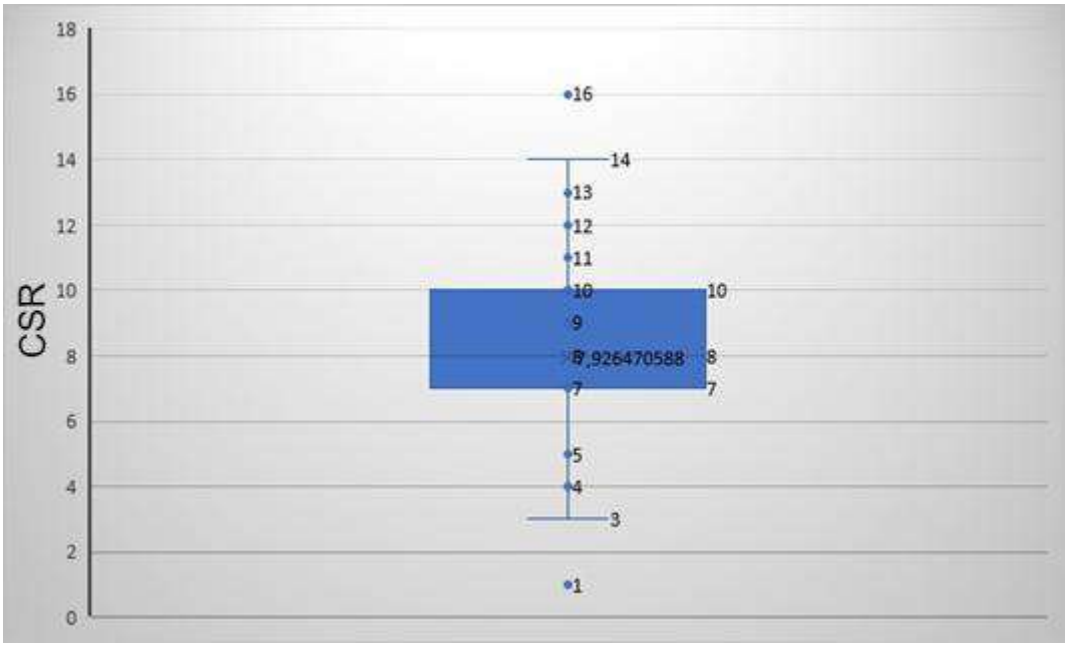

Figure 24. Distribution of COVID-19 patients, taking into account age

It can be seen from the figure that the samples by gender and age are homogeneous. The data obtained confirm the information in the literature that patients who had previously been ill with COVID-19 have a high activity of the carious process.

In the emergence and development of the carious process and its complicated forms, the hygienic condition of the oral cavity is important.

The Green-Vermillion index was used to assess the level of oral hygiene in patients who had previously undergone COVID-19. The results obtained are shown in table 14.

Table 14 - Levels of oral hygiene in patients who had previously had COVID-19

Hygienic condition of the oral cavity	Well	Satisfactory	Unsatisfactory	Bad	Total patients
Number of patients	36 (30,8%)	27 (23,0%)	43 (36,8%)	11 (9,4%)	117 (100%)

The results obtained indicate that patients who have had COVID-19, who have an active development of the carious process and, as a result, pulpitis and periodontitis, predominantly have a fairly low level of oral hygiene. In 43 patients, unsatisfactory oral hygiene is noted, which is 36.8%, satisfactory hygiene in 27 patients, which is 23.0%, a good level of oral hygiene is noted in 36 patients, which is 30.8%. And 11 patients have a poor level of oral hygiene.

All 117 patients underwent electrodontodiagnostics, which demonstrated data confirming the diagnosis. An electrodontometer EOT 1.1 (Aveyron, Russia) was used for the study. The electrical excitability of the tooth pulp in chronic gangrenous pulpitis, and even more so in acute purulent periodontitis or exacerbation of one or another form of chronic periodontitis, is noticeably reduced, since necrosis of the pulp tissue excludes the possibility of a normal response of the neurovascular bundle of the tooth.

The results of electrodontometry are presented in Table 15.

Table 15 - Distribution of the results of the average electrometric examination in patients with COVID-19

Diagnosis	The value of the diagnostic current, mkA					Total
	up to 6	1-25	25-60	60-100	over 100	
Chronic gangrenous pulpitis	-	-	17 people	52 people	-	
Exacerbation of chronic periodontitis	-	-	-	-	48 people	
Total	-	-	17 people	52 people	48 people	117

In 17 subjects, which amounted to 14.5%, EOT indicators are in the range from 25mkA to 60mkA, in 52 (44.5%) – in the range from 60mkA to 100mkA, in 48 (41%) – more than 100mkA.

The next step was to perform targeted radiography and orthopantomography for all 117 patients. The X-ray picture corresponded to the alleged diagnosis and confirmed them. Examples of X-ray examination are shown in Figures 25-28.

An orthopantomogram could determine the presence of foci of bone tissue destruction and foci of infection, if any, as well as their number. On the sighting images, we analyzed the variability of the periodontal fissure, the size of foci of bone tissue destruction in their presence, the degree of passage and curvature of root canals, their number, the ratio of the carious cavity and the roof of the pulp chamber, the consistency of old restorations [24].

Figure 25. Chronic gangrenous pulpitis of the tooth 2.5

Figure 26. Chronic gangrenous pulpitis of the tooth 1.6

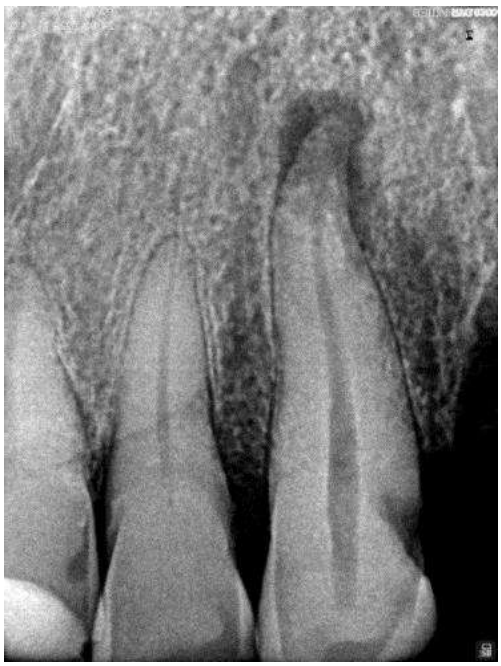

Figure 27. Exacerbation of chronic granulomatous periodontitis of the tooth 2.3

Figure 28. Orthopantomogram of a patient who has had COVID -19

Due to the presence of the above aspects, when working with such patients, it becomes necessary to conduct additional examination methods (bacterioscopy, bacteriology), and when identifying a bacterial agent, it is advisable to introduce a narrowly targeted therapy that has a predominant effect on the identified microflora.

3.2. The results of the bacterioscopic and bacteriological research method

Bacterioscopy of the tooth pulp is the simplest and less labor-intensive method, the main purpose of which is to detect the microbial component of inflammation in the preparation of the contents of the root canal of the tooth.

It is known that the rates of colonization of Candida can vary not only depending on the characteristics of individual tissues and organs, but also on the influence of various endogenous and exogenous factors, while under certain conditions fungi can invade intact tissues and cause not only limited, but even generalized invasive processes.

117 patients who had COVID-19 underwent bacterioscopic examination of the possessed root canals of teeth with a diagnosis of "chronic gangrenous pulpitis" and "exacerbation of chronic periodontitis".

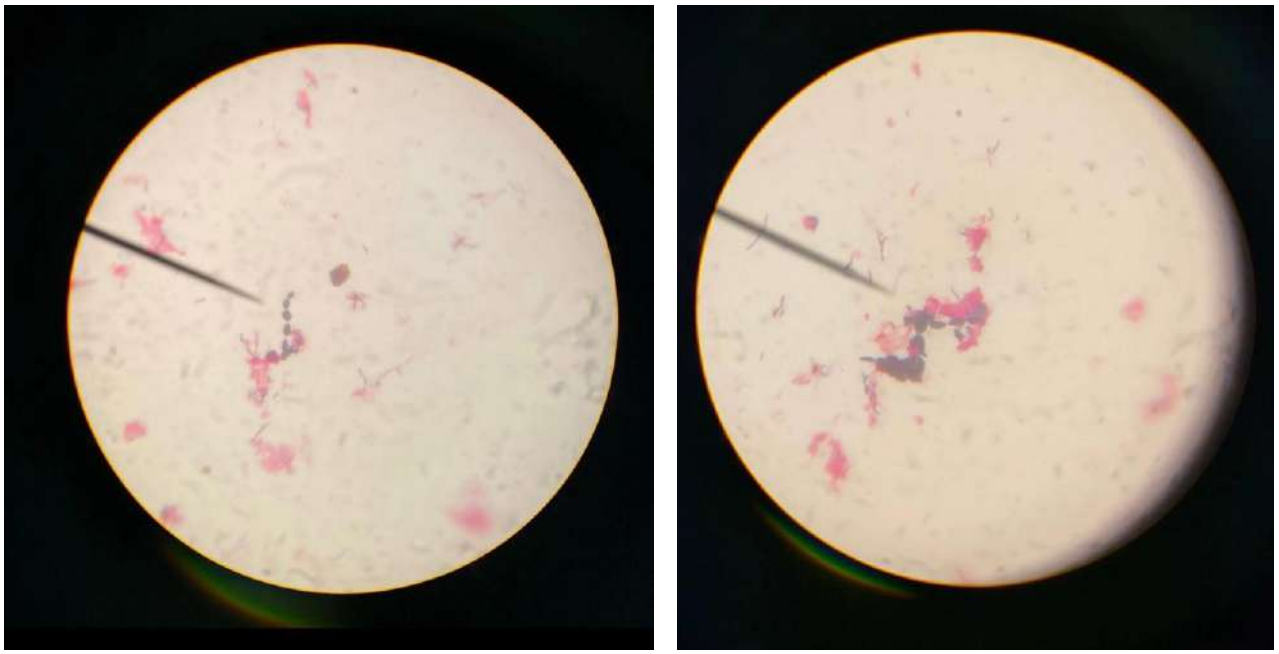

Figure 29. Bacterioscopy of the pulp

Microscopy of 117 dental pulp preparations stained with hematoxylin-eosin revealed the presence of coccal flora in all cases (100%) and in 98 cases (83.8%) revealed elements of yeast-like Candida fungi [21, 24].

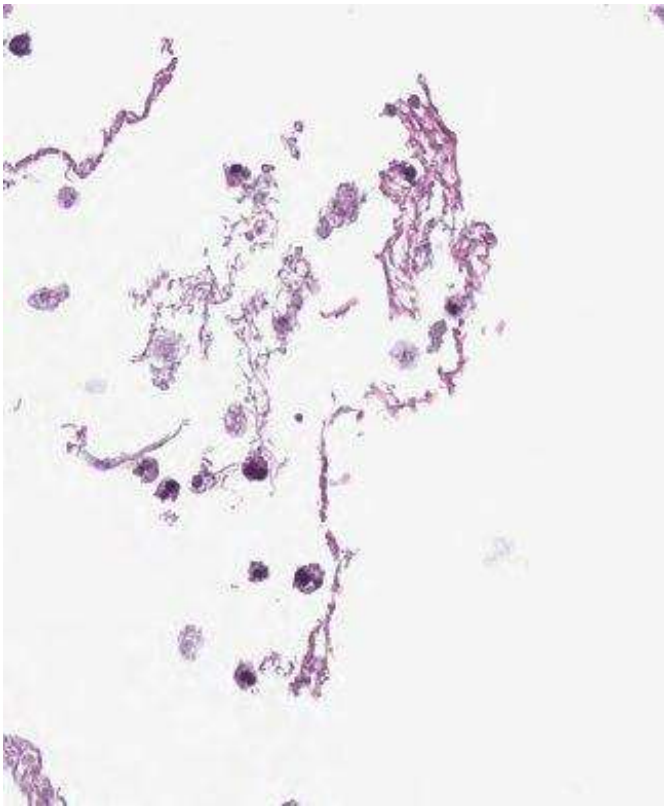

Figure 30. Pseudomycelia of fungi of the genus Candida

In Figure 29, you can see thin-walled rounded or elongated cells with a diameter of about 5 microns, which are characteristic of yeast-like fungi of the genus Candida. This is how young cells are represented. In addition, there are larger cells - up to 15 microns, which represent mature representatives of fungi of the genus Candida.

Figure 30 shows the reproduction of cells using pseudomycelia, which have the appearance of elongated cells that touch a narrow base. Also, the presence of chlamydospores is a characteristic feature of Candida albicans fungi.

The results of the bacterioscopic examination are shown in Table 16.

Table 16 - Results of bacterioscopic examination of the contents of the pulpo-periodontal complex of teeth

Number of drugs with Candida albicans	Stages of pseudomycelia growth				Total
	young	mature	old	degenerate.	
One field of view	7	3	-	-	10 (10,2%)
2-3 fields of view	28	46	14	-	88 (89,8%)
TOTAL	35	49	14	-	98 (100%)

Next, a bacteriological study (cultural study) of the contents of the pulpoperiodontal complex was carried out in order to identify the type of fungus. Bacteriological examination is the second stage of laboratory diagnostics and was carried out to confirm and concretize the previously obtained results [21].

During the work, a bacteriological study was conducted in 49 patients who had previously been ill at different times with COVID-19, diagnosed with "exacerbation of chronic periodontitis", "chronic gangrenous pulpitis" in order to identify Candida fungi in the root canal system of the tooth. Previously, all patients were divided into groups according to the final diagnosis, which was made on the basis of data from a standard clinical trial and the results of additional research methods (electrodontometry, X-ray diagnostics, temperature test).

The first group with a diagnosis of chronic gangrenous pulpitis included 27 patients. The second group with the diagnosis of "exacerbation of chronic periodontitis" included 22 patients.

The first observation was carried out after 48 hours. The final characterization of the obtained crops was carried out on day 5.

In the first group of patients, already at the first observation, in 21 out of 27 cases, which amounted to 77.8%, smooth convex black colonies with an even edge in the form of a hemisphere, with an approximate diameter of 1.0-2.0 mm, were

obtained on a dense Saburo medium. In the final study, black Candida Albicans colonies were observed in 100% of cases. In the second group of 22 cases, Candida Albicans colonies were observed in large numbers in 20 patients (84.6%) at the first observation. On the 5th day of observation, the colonies acquired a more convex appearance. In 2 cases (15.4%), no growth of Candida Albicans colonies was observed [21].

The data obtained are shown in Figure 31.

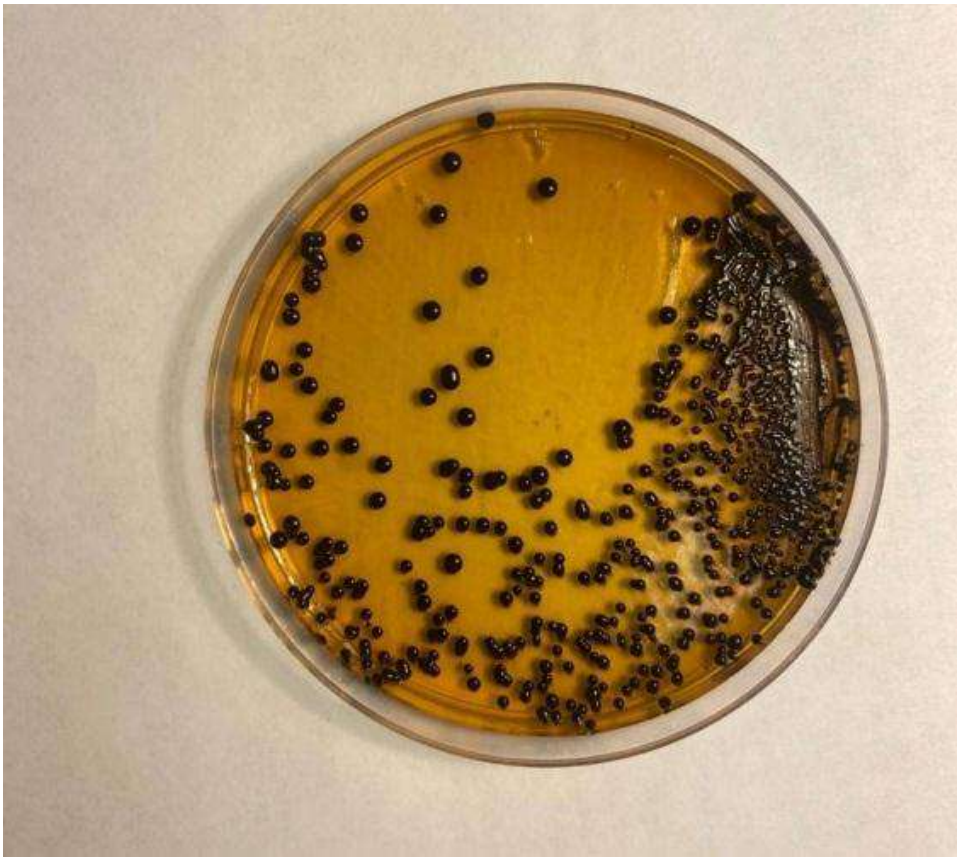

Figure 31. Candida Albicans colonies on Saburo medium

Indicators of the intensity of growth of colonies of fungi of the genus Candida are presented in Table 17.

Table 17 - Growth rate of Candida albicans colonies on Saburo nutrient medium seeded from the contents of the pulpoperiodontal complex of teeth of patients who had previously had COVID-19

Name	The intensity of colony growth on a solid Saburo medium				Total research (n=49)
	very meager up to 10 CFU	meager 10-25 CFU	moderate more than 50 CFU	Abudant growth is incalcul. colonies	
Primary research	4 (10,5%)	7 (18,4%)	21 (55,3%)	6 (15,8%)	38 (100%)
Repeated research	- (0%)	5 (45,5%)	4 (36,4%)	1 (9,1%)	11 (100%)

CFU represents the number of colonies in the studied material. According to the data obtained, in 4 out of 38 cases, which amounted to 10.5%, very poor colony growth was detected during the initial study of sowing on a solid Saburo medium. Meager growth was detected in 7 out of 38 cases in the initial study, which amounted to 18.4%. In 21 cases out of 38, there was a moderate growth of colonies, which amounted to 55.3% of cases. And in 6 cases, there was an abundant growth of colonies, when the number of colonies could no longer be counted.

Upon repeated examination, a meager increase in the number of colonies on a Petri dish was detected in 5 and 11 crops, which amounted to 45.5%. In 4 out of 11 studies, which amounted to 36.4%, moderate growth of culture was found. In 1 out of 11 cases, which amounted to 9.1%, abundant colony growth was observed.

The data obtained confirm the need to introduce an antimycotic component into the endodontic treatment of chronic gangrenous pulpitis, exacerbation of chronic periodontitis in patients who have had COVID-19, despite the fact that only in the contents of the root canals of 98 teeth such a component of mycotic flora as Candida Albicans was identified and confirmed.

3.3. The results of the evaluation of the effect of antifungal drugs on mycotic flora

A disco diffusion method was used to determine the sensitivity of yeast-like fungi of the genus Candida albicans to the antimycotic drugs Nystatin, Fluconzole, Amphotericin B, Ketoconazole, Clotrimazole, and Itraconazole.

The main purpose of the study is to identify the most effective antimycotic drug for isolated flora containing Candida Albicans in patients who have had COVID-19.

The study was carried out on 48 Saburo nutrient media, where colonies of strains of fungi of the genus Candida albicans were previously sown, identified during a previous bacteriological examination of the contents of the root canals of teeth in patients who had previously been ill with COVID-19. The discs were arranged in 2 pieces, impregnated with different preparations, at a distance from each other. Thus, 96 discs with drugs were located in 48 Petri dishes. Among them, each antifungal drug has 16 pieces.

The effectiveness of antimycotic drugs was analyzed by measuring the diameter of the growth suppression zone of Candida Albicans culture. The data obtained were compared with indicators corresponding to the sensitivity and resistance of each antimycotic drug, fixed by the Pharmacotherapy Research Center. The results obtained are shown in Figures 32, 33, 34.

Figure 32. The effectiveness of the drugs "Ketoconazole" and "Fluconazole" on a colony of Candida Albicans in a cup with Saburo medium

Figure 33. The effectiveness of the drugs "Nystatin" and "Amphotericin" on a colony of Candida Albicans in a cup with Saburo medium

Figure 34. The effectiveness of the drugs "Clotrimazole" and "Itraconazole" on a colony of Candida Albicans in a cup with Saburo medium

Table 18 presents the results of a study of the effectiveness of antifungal drugs to the detected contents of root canals containing Candida Albicans.

Table 18 – Effectiveness of antimycotic drugs against Candida Albicans detected in the contents of the pulpoperiodontal complex of patients who had COVID-19

Name of the drug	«stable»	«sensitive»	Total
Amphotericin B	9 (56,25%)	7 (43,75%)	16 (100%)
Nystatin	11 (68,75%)	5 (31,25%)	16 (100%)
Fluconazole	2 (12,5%)	14 (87,5%)	16 (100%)
Clotrimazole	12 (75%)	4 (25%)	16 (100%)
Itraconazole	16 (100%)	0 (0%)	16 (100%)
Ketoconazole	6 (37,5%)	10 (62,5%)	16 (100%)

Thus, when examining the growth zone of fungi of the genus Candida albicans around discs with the drug "Fluconazole" in 14 media out of 16, the diameter of the culture growth suppression was more than 19 mm, which indicates a high sensitivity of Candida albicans to this drug in 87.5% of cases. When studying the sensitivity of the drug Ketoconazole in a larger number of cases, flora was sensitive to its action, which amounted to 62.5%. But the result of the action is lower than that of "Fluconazole". Also, according to the data obtained, Candida albicans is sensitive to "Amphotericin B" in 43.75% of cases and resistant in 56.25%. In the study of the drug "Nystatin", it was found that the flora is more resistant to its action, which amounted to 68.75%. Similar results were shown by the drugs Clotrimazole, which is 75% resistant to action, as well as Intraconazole, to which flora is resistant in 100% of cases.

Figure 35 shows a diagram of the scope of the studied drugs.

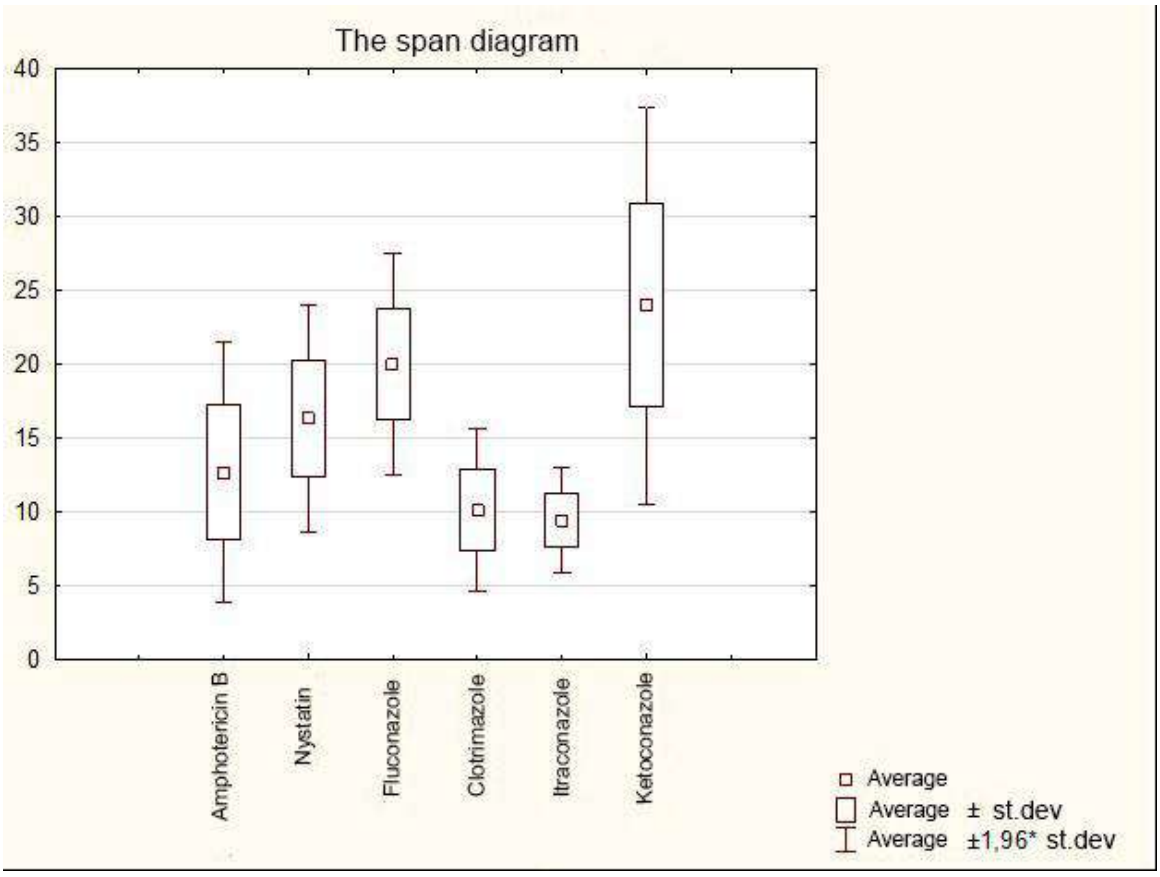

Figure 35. A diagram of the scope of the studied drugs

To determine the statistical significance of the results obtained for the studied drugs, the Kraskel-Wallis criterion was used. The null hypothesis H0 was tested in the Statistica 10 statistical package: there are no statistically significant differences in the studied drugs. Alternative hypothesis H1: Differences in the drugs used are statistically significant. The results of the hypothesis testing are shown in Figure 36.

Addiction: Diameter of culture growth suppression	Kraskel-Wallis rank index; Diameter of growth suppression Group (independent) variable: Kr.Kraskel-Wallis drug: H (5, N= 96) =59.18612 p =,0000			
	Code	Valid N	The sum of ranks	Average Rank
Amphotericin B	1	16	620,500	38,78125
Nystatin	2	16	909,500	56,84375
Fluconazole	3	16	1146,000	71,62500
Clotrimazole	4	16	397,500	24,84375
Itraconazole	5	16	339,000	21,18750
Ketoconazole	6	16	1243,500	77,71875

Figure 36. The result of the test according to the Kraskel-Wallis criterion for determining the statistical significance of the effectiveness of the studied drugs (6 names)

The results of the Kraskel-Wallis test, shown in Figure 36, demonstrate that the null hypothesis of the absence of statistically significant differences in the studied drugs can be rejected, since the achieved significance level ($p=0.000$) < 0.01. This means that in 1% of cases we are ready to reject the correct null hypothesis, i.e. to make a decision about the presence of differences where they actually do not exist (error of the 1st kind).

In addition, a cluster analysis was carried out for the studied drugs, the results of which are shown in Figure 37. From which three clusters are distinguished:1 – the most effective Fluconazole and Ketoconazole; 2 – medium–effective Nystatin and Amphotericin B; 3 - low-effective Intraconazole and Clotrimazole.

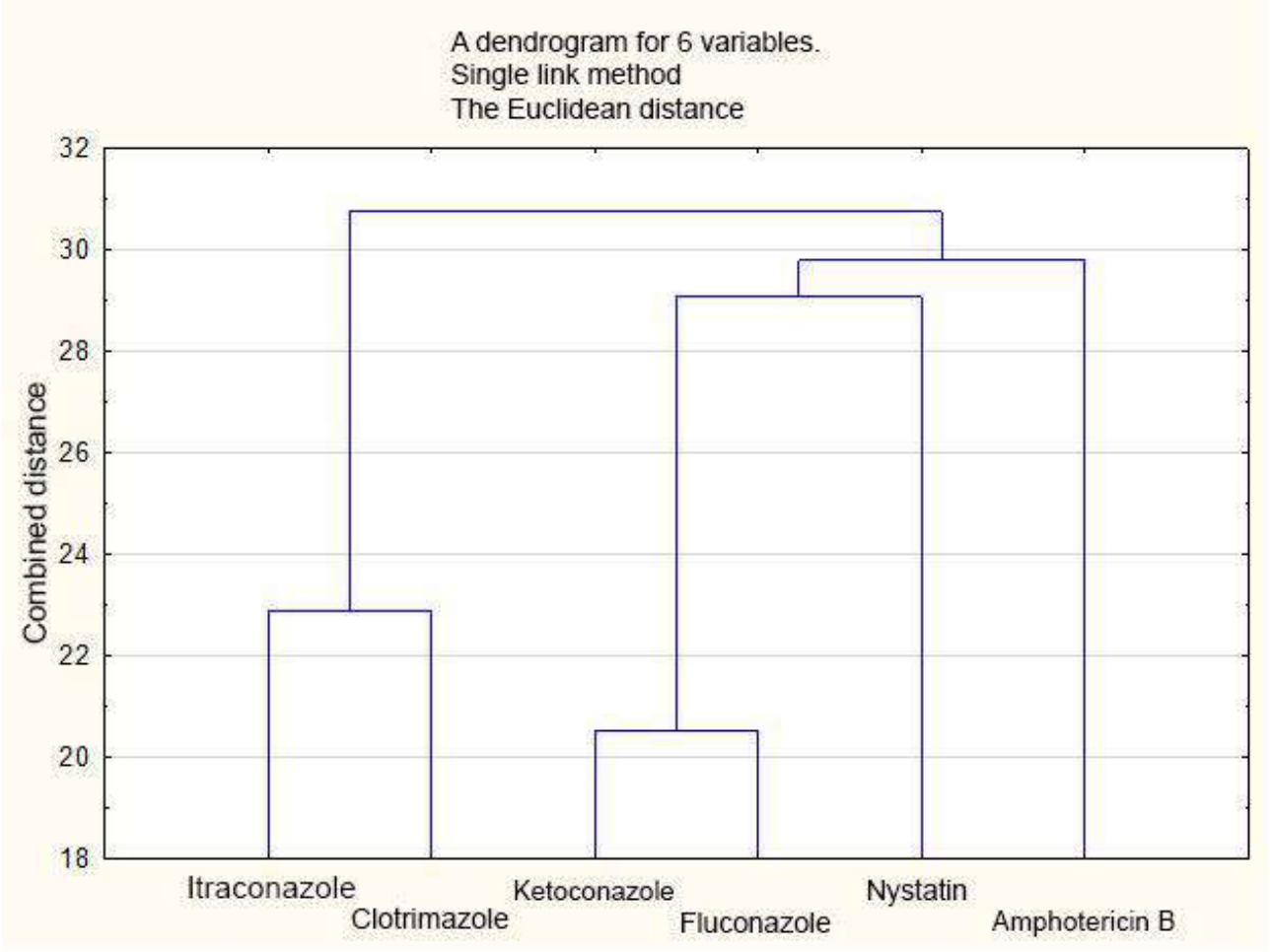

Figure 37. Dendrogram of the studied drugs by effectiveness (6 names)

Since, based on studies (Rolsen T., Schell B.-J., Orengo I. Int. J. Dermatol. 1997; Russell E. Lewis, Pharm.D.,2001;), an antifungal drug has an anti-inflammatory effect by affecting the coccal flora, the use of an antifungal drug should be carried out in all patients.

According to the data obtained, the antifungal drug "Fluconazole" may become effective against the identified mycotic component in the inflamed pulp during endodontic treatment [11].

3.4. The results of a comparative assessment of the effectiveness of complex suspension treatment using an antifungal component

Patients who had COVID-19 were divided into 4 groups: patients from two groups received traditional treatment, patients from the other two groups received modified treatment with the introduction of an antimycotic component.

Endodontic treatment was carried out in several stages. During the second stage of treatment, repeated bacteriological seeding of the contents of the prepared root canals for the presence or absence of microflora was also carried out, the results of which are shown in Table 19.

Table 19 - Results of repeated bacteriological examination in patients of all study groups

Microflora	Frequency of occurrence, % (after root canal treatment)			
	1st group n=36	2nd group n=33	3rd group n=25	4th group n=23
Streptococcus mutans	6 (1,75%)	2 (6,1%)	3 (16,0%)	2 (8,6%)
Streptococcus intermedius	3 (8,3%)	0	1 (4,0%)	0
Candida albicans	14 (38,9%)	1 (3,0%)	6 (24,0%)	1 (4,3%)

As follows from Table 19, Candida albicans in the root canals after antimycotic therapy in the treatment of chronic gangrenous pulpitis in patients who had previously had COVID-19 were detected in 1 patient out of 33 (3.0%), whereas with the standard treatment protocol – in 18 patients out of 36 (38.9%).

After antimycotic therapy in the treatment of exacerbation of chronic periodontitis in patients who had previously had COVID-19, Candida albicans in

the root canals were detected in 1 patient out of 10 (4.3%), while with the standard treatment protocol – in 6 patients out of 25 (24.0%).

According to the results obtained, the expected effect of "sterility" of root canals is not always achieved when carrying out the traditional standard protocol of endodontic treatment in patients with diseases of the pulp and periodontal of the tooth who underwent COVID-19 at different times.

The results of repeated bacteriological studies demonstrate that Candida Albicans, present in the contents of the root canals of teeth in patients who have had COVID-19, demonstrates relative resistance to traditional drug treatment. While in groups where an antimycotic component was introduced into the treatment, a more effective result of exposure to yeast-like fungi of the genus Candida is observed.

Nevertheless, in the second and fourth groups, there are isolated cases of Candida Albicans detection after a modified treatment with an antimycotic component. Such results may be related to the fact that the structure of the root system, as well as the root canals, was anatomically complex for appropriate high-quality mechanical and medical treatment.

The effectiveness of long-term results of complex treatment of patients who had COVID-19 and sought endodontic treatment from a dentist was determined within 3 months, then after 6 months and the last control after 12 months. Control examinations and X-ray diagnostics were carried out using a sighting image of the tooth. The effectiveness of complex treatment was evaluated according to the following criteria: the absence or presence of a patient's complaint of painful sensations during chewing, assessment of the quality of obturation of the root canal system through X-ray examination, the presence or absence of inflammatory processes in the area of the treated tooth during examination, palpation and percussion of the tooth, as well as the presence or absence of periapical changes in the tooth area or signs of bone regeneration according to a targeted X-ray.

The following factors spoke in favor of the effectiveness of the complex treatment with the introduction of antimycotic therapy at the stage of control examination and anamnesis collection:

- no complaints from the patient;
- upon visual examination, the mucous membrane in the area of the treated tooth is normal, without rashes, swelling and signs of inflammation;
- tooth percussion is negative, painless;
- palpation in the area along the transitional fold is painless;
- restoration of a tooth made of composite material or orthopedic construction is sound, without defects.

The following factors support the effectiveness of the complex treatment, which includes the introduction of anti-fungal therapy at the stage of X-ray monitoring using imaging techniques

- root canals are lined to the top, homogeneously, without filling defects;
- there are no periapical changes;
- the previously existing destruction of bone tissue has a positive trend towards recovery.

The ineffectiveness of endodontic treatment under X-ray control will be determined within 24 months of the treatment and more. The following factors spoke in favor of the ineffectiveness of the complex treatment with the introduction of antimycotic therapy at the stage of X-ray control by means of sighting images:

- lack of positive dynamics in periodontal tissues;
- deterioration of previously existing periapical changes.

An example of the positive dynamics of complex treatment is shown in Figure 38. Patient B, 47 years old, who sought dental help with complaints of pain from temperature stimuli, mainly hot, a feeling of discomfort when chewing, bad breath. It also became known from the life history that in 2021 the patient suffered COVID-19, was treated at home, took medications prescribed by a doctor (amoxiclav, favipiravir, grippferon, ibuprofen, multivitamin complex).

At the dentist's appointment, the entire complex of diagnostic measures was carried out, after which the diagnosis of "Chronic gangrenous pulpitis" of tooth 1.6 was established. The patient belonged to group 2, an antimycotic component was introduced during treatment. A dental examination and X-ray examination after 12 months were recommended. The data is shown in Figure 38.

Figure 38. Patient B., tooth 1.6 after endodontic treatment after 12 months

The patient has no complaints, percussion is negative. There are no periapical changes on the X-ray sighting image, the root canals are sealed homogeneously with radiopaque material, the seal is consistent. The patient does not need repeated endodontic treatment. The tooth was restored with IRM material (Dentsply Sirona, USA). Next, it is recommended to restore the tooth with an orthopedic structure (take a bridge prosthesis as a support tooth in the area 1.6 – 1.4).

To determine the statistical significance of the above results, the Mann-Whitney criterion was used.

Initially, the test was done for groups 1 and 2. The null hypothesis H0 was tested: there are no statistically significant differences in the effectiveness of complex suspension treatment using an antifungal component and the traditional method. Alternative hypothesis H1: The differences in the methods are statistically significant. The results of the hypothesis testing are shown in Figure 39.

Var.	U Mann-Whitney criterion (1-2-Repeated bac. research sta) According to var. Group The noted criteria are significant at the level of p <,01000									
	Sum. rank 1	Sum. rank 2	U	Z	p- lvl	Z corr.	p- lvl	N 1	N 2	2- sided precise
Microflora	1576,000	839,0000	244,0000	4,206841	0,000026	4,869935	0,000001	35	34	0,000013

Figure 39. The result of the Mann-Whitney test to determine the statistical significance of the new technique in the case of chronic gangrenous pulpitis

The results of the Mann-Whitney test (Figure 39) show that the null hypothesis of the absence of statistically significant differences in the new method and the traditional method in the treatment of chronic gangrenous pulpitis can be rejected, since the achieved significance level (p=0.000) < 0.01. Thus, with a probability of 0.99, it can be argued that the new method of treating chronic gangrenous pulpitis is more effective.

The Mann-Whitney criterion was used to determine the statistical significance of the above results.

Initially, the test was done for groups 3 and 4. The null hypothesis H0 was tested: there are no statistically significant differences in the effectiveness of complex suspension treatment using an antifungal component and the traditional method. Alternative hypothesis H1: The differences in the methods are statistically significant. The results of the hypothesis testing are shown in Figure 40.

Var.	U Mann-Whitney criterion (3-4-Repeated bac. research sta) According to var. Group The noted criteria are significant at the level of p <,05000								
	Sum. rank Group 1	Sum. rank Group 2	U	Z	p- lvl	Z corr.	p- lvl	N group 1	N group
Microflora	747,5000	578,5000	227,5000	1,827696	0,067596	2,393635	0,016683	25	

Figure 40. The result of the Mann-Whitney test to determine the statistical significance of the new technique in the case of exacerbation of chronic periodontitis

The results of the Mann-Whitney test (Figure 40) show that the null hypothesis of the absence of statistically significant differences in the new technique and the traditional technique in the treatment of exacerbation of chronic

periodontitis can be rejected, since the achieved significance level ($p=0.000$) < 0.05. Thus, with a probability of 0.95, it can be argued that the new treatment method is more effective in the case of exacerbation of chronic periodontitis.

CONCLUSION

The problem associated with the outbreak of the COVID-19 epidemic has affected all branches of medicine, including dentistry. The effect of exposure to the SARS-CoV-2 virus on oral diseases remains poorly understood. However, the detection of the SARS-CoV-2 virus in saliva indicates its presence and vital activity in the oral cavity itself. There are studies that demonstrate the expression of ACE-2, a receptor for the SARS-CoV-2 virus, in oral tissues. In patients who have suffered from COVID-19 in severe or moderate severity, cytokine storm and abundant secretion of proinflammatory cytokines such as IL-6, IL-1β and TNF-α in various oral pathologies, which include pulpitis, periapical periodontitis, periodontitis, suggest that the inflammatory microenvironment is distinctive a feature of both COVID-19 and oral diseases. The resulting hyperinflammation can create a favorable microenvironment for the growth of pathogenic and opportunistic microorganisms, as well as have a detrimental effect on the integrity of the tissues of the oral cavity, hard tissues and neurovascular bundle. Numerous studies and observations indicate that patients who have been ill with COVID-19 at different times have uncharacteristic lesions and diseases in the oral cavity: symptomatic irreversible forms of pulpitis, acute forms of periodontitis, more abundant deposition of supra-gingival and subgingival dental deposits, ulcerative necrotic gingivitis. These observations suggest that SARS-CoV-2 can worsen and change the manifestations of various diseases in the oral cavity.

An increase in the activity of conditionally pathogenic microorganisms, normally which do not show active activity in the oral cavity, gives rise to the development of various pathologies of the hard tissues of the teeth, pulp and periodontal tooth, periodontal tissue complex, oral mucosa. For this reason, patients who have previously undergone COVID-19 have an atypical course of these diseases, which is expressed in:

- an increase in the frequency of exacerbations of chronic and sluggish diseases;

- a blurred history of the disease, in which patients cannot accurately indicate the time and what the complaints are related to;

- a vague clinical picture characteristic of a particular disease;

- the transition of various pathogenetic manifestations into a purulent or necrotic form.

Based on the data of the conducted examinations of patients with the presence of COVID-19 in previous diseases, it is possible to justify the expediency and need to include in this category of patients, in addition to the standard dental examination, additional examination methods (blood test, bacteriological examination, examination of the microcirculatory bed, and others) before starting any dental treatment. It is important to diagnose dental manifestations in time and choose the most adapted algorithm for the treatment of pathology, depending on the clinical manifestations in the oral cavity.

Based on the data of the conducted examinations of patients who had previously been ill with COVID-19, it is possible to justify the expediency and necessity of including in this category of patients, in addition to a standard dental examination, additional examination methods, in particular bacterioscopy of the tooth pulp, in order to determine the microbial composition of the microflora of the contents of the root canal. Based on this, the dentist will be able to choose the most correct method of treating complicated forms of dental caries, focusing on the elimination of a certain type of microorganism identified using additional examination methods and thereby preventing the occurrence of long-term complications after endodontic treatment of the tooth.

Bacterioscopic examination is a fairly simple and affordable diagnostic method that can be performed by a dentist in a dental office, having a simple microscope and the necessary dyes in his arsenal.

During endodontic treatment, insufficient attention is usually paid to the assessment of the bacterial complex of the contents of the pulpoperiodontal complex

of the tooth. At the same time, the frequency of complications after previous treatment of pulpitis and periodontitis remains quite high. This may be due to the composition and properties of microbial biofilms located in root canals.

Various microorganisms that are part of the biofilm are isolated. Among them: Streptococcus, Enterococcus spp., Staphylococcus, Fusobacterium spp., Peptostreptococcus spp., Candida spp.

According to studies of the composition of the microflora of E. faecalis and C. albicans, they are often found in previously sealed root canals at the stages of repeated endodontic treatment in inhomogenously sealed root canals, in places free of therapeutic and filling materials, dental canals between visits, in cases of treatment in several stages. The presence of these microorganisms leads to the appearance of secondary infection in the root canals: in 77% of cases - E. Faecalis, in 20-25% Candida Albicans. Since microorganisms coexist in a structured biofilm colony, this makes them more resistant to various medications for root canal irrigation and temporary therapeutic dressing.

According to our research, microscopy of 117 preparations of the contents of the pulpoperiodontal tooth complex taken from patients who had previously had COVID-19 revealed elements of yeast-like Candida fungi in 98 cases (83.8%).

Later, a bacteriological laboratory study confirmed and specified the results of bacterioscopy. Candida Albicans colonies in 95.92% were found on Saburo nutrient agar. Thus, the presence of Candida Albicans fungi in the contents of the pulpoperiodontal complex of teeth in patients who had previously been ill with COVID-19 at different times was confirmed.

The opinion that Candida is a resistant microorganism to modern medications used in traditional methods of endodontic treatment is supported by the way yeast-like fungi of the genus Candida are found in the root canals of teeth with endodontic treatment already performed. In periodontal tissues, the presence of an inflammatory process can be maintained for a long time, the reason for which may be the

incomplete elimination of microorganisms such as Enterococcus faecalis and Candida albicans. This can lead to subsequent complications after endodontic treatment.

All this served as the basis for our proposed modification of the method of complex endodontic treatment of pulp and periodontal diseases (patent for invention No. 2810424 "Method for the treatment of chronic gangrenous pulpitis in patients with COVID-19, when mycotic flora is detected in the tooth pulp". Ermolovich A.L., Borisova E.G.), including a complex effect of an antimycotic drug inside and topically in the root canals of the tooth.

The results of repeated bacteriological studies demonstrate that Candida Albicans, present in the contents of the root canals of teeth in patients who have had COVID-19. This indicates the relative resistance of these microorganisms to traditional medical treatment of the root canals of teeth. While in groups where an antimycotic component was introduced into the treatment, a more effective result of exposure to yeast-like fungi of the genus Candida is observed.

But despite the high effectiveness of the proposed method, at the same time, in group 2 and group 4, there are isolated cases of Candida Albicans detection after a modified treatment with an antimycotic component, which may be caused by the complex anatomical structure of the root canal system of the tooth.

The results of our research prove the effectiveness of the integrated introduction of an antimycotic component into the treatment protocol for complicated forms of dental caries in patients who have had COVID-19. This method is a modification of the traditional method of endodontic treatment of dental pulpitis and periodontitis. During the control examination and anamnesis collection, the absence of complaints in patients was revealed, the mucous membrane in the area of the treated tooth is normal, physiological color, painless on palpation, vertical percussion of the tooth is painless, tooth restoration is consistent, without defects.

X-ray examination showed: obstructed root canals to the tip, absence of periapical changes, which indicates the effectiveness of endodontic treatment.

The integrated approach proposed by the authors makes it possible to have a narrower effect on the microbial composition of the pulpoperiodontal complex of teeth in patients who had previously undergone COVID-19 at different times, thereby improving the quality of endodontic treatment and reducing the risk of long-term complications.

SUMMARY

1. The standard set of diagnostic measures used at the clinical reception is insufficient to choose the tactics of endodontic treatment of patients who have been ill with COVID-19, with identified complicated forms of dental caries. The complex of diagnostic measures proposed by us and used in practice, which includes, in addition to standard diagnostic measures, bacterioscopic examination and bacteriological examination, proved to be more informative.

2. Bacterioscopic examination of the contents of the root canals of the tooth of patients who had COVID-19 made it possible in 98 cases (83.8%) to identify elements of yeast-like Candida fungi and identify young and mature forms of pseudomycelia, which indicates the activity of Candida fungi in dental pulp and periodontal pathology. With the help of bacteriological research, the obtained bacterioscopy data were confirmed and specified by seeding the material on nutrient agar and identifying Candida Albicans fungi.

3. According to the data obtained, the antifungal drug "Fluconazole" was identified as the most effective against the identified mycotic component in the pulpoperiodontal complex of teeth during endodontic treatment in patients who have had COVID-19.

4. The proposed method of complex treatment of pulpitis and periodontitis of teeth in patients who have had COVID-19, with the inclusion of the drug "Fluconazole", demonstrates a more effective result of exposure to yeast-like fungi of the genus Candida, which show relative resistance to traditional treatments.

PRACTICAL RECOMMENDATIONS

1. For patients with inflammatory diseases of the pulpo periodontal complex, it is recommended to introduce bacterioscopic examination of the contents of the root canals of the tooth in order to select highly specialized therapy for the identified microbial agents.

2. For patients who have had COVID-19 at different times, it is recommended to introduce antimycotic drugs into the endodontic treatment of chronic gangrenous pulpitis and exacerbation of chronic periodontitis, due to the presence of Candida fungi in the root canal system of teeth.

LIST OF ABBREVIATIONS

COVID-19 – coronavirus infection in 2019

C. Albicans – Candida Albicans

IL-6 – interleukin 6

IL-1β – interleukin 1 beta

SARS-CoV-2 – RNA genomic virus of the genus Betacoronavirus of the Coronavirida familye

TNF-α – tumornecrotic factor alpha

DAR – Dental Association of Russia

MSC – minimum suppressive concentration

EOT – electrodontodiagnostics

EDTA – ethylenediaminetetraacetic acid

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