The use of an Ozone Generator that Produces Ozone Using Ultraviolet Radiation for Ozonize the Contact Medium in the Treatment of Gingivitis of Young People

Mkhoyan G. R.[1], Razumova S. N.[1], Volkov A. G.[2], Dikopova N. J.[2], Brago A.S.[1], Bait Said O.M.H.[1]*, Akhmedbaeva S.S.[2], Serebrov K.D.[2]

1. Peoples' Friendship University of Russia, Moscow, Russia.
2. Federal State Autonomous Educational Institution of Higher Education I.M. Sechenov First Moscow State Medical University of the Ministry of Health of the Russian Federation (Sechenov University), Moscow, Russia.

Abstract

In order to study the effectiveness of dental plaque removal using low frequency ultrasound and an ozonated contact medium obtained from an ozone generator by ultraviolet radiation in the treatment of catarrhal gingivitis of young people the 54 patients aged from 18 to 22 years with a diagnosis of chronic generalized catarrhal gingivitis were examined and treated. All patients were divided into two groups of 27 in each one. The first group was a control group and these patients had dental deposits removed without ozonation of the contact medium. In the second group the removal of dental deposits performed with ozonation of the contact medium obtained from an ozone generator producing ozone by ultraviolet radiation. The level of hygiene was assessed by the Oral Hygiene Index Score (OHI-S). The inflammation severity was assessed using the Papillary Marginal Alveolar Index (PMA). The Papilla Bleeding Index (PBI) used to assess bleeding gums. Determination of capillary resistance to vacuum was carried out according to the Kulazhenko method using the device for vacuum laser treatment "DESNA".

The analysis of rheoparodontograms included qualitative and quantitative assessment. Dental plaque removal using low frequency ultrasound and an ozonated contact medium obtained from an ozone generator by ultraviolet radiation help to reduce inflammation, normalize local blood circulation in the periodontium, prolong the remission time and stabilize the process.

Clinical article (J Int Dent Med Res 2022; 15(1): 250-254)

Keywords: Catarrhal gingivitis, ozonated contact medium, removal of dental plaques, ozone generator, ultraviolet radiation.

Received date: 10 January 2022 **Accept date:** 27 February 2022

Introduction

Our days characterized by the widespread medical use of ozone therapy in general and particularly in dentistry. According to the majority of researchers the ozone therapy is a highly effective treatment method with bactericidal, immunomodulatory, antihypoxic and detoxifying effects [1, 2, 3]. The mechanism of therapeutic effect of ozone therapy is associated with a high oxidizing potential of ozone which provides on the one hand a disinfecting effect against bacteria, viruses and fungi, on the other hand leads to the activation of metabolic processes in tissues [4, 5].

*Corresponding author:
Bait Said O.M.H.
117198, 6. Miklukha Maklaya, Moscow, Russia.
E-mail: milk10milk@hotmail.com

There are two main ways to produce ozone – by electric discharge (electrosynthesis) and by short ultraviolet rays (photosynthesis).

Electrosynthesis of ozone has become the most widespread as it allows the production of ozone in high concentrations. However, when obtaining ozone by this method there is a significant problem associated with the fact that in addition to oxygen from which ozone is generated, there are a lot of nitrogen molecules in the air. So an electric discharge dissociates not only oxygen molecules producing ozone but also nitrogen molecules which then convert into nitrogen oxides and further by reaction with water into nitric acid. In this regard ozonators of this type are dangerous to use in a humid environment of the oral cavity because the resulting nitric acid can have a damaging effect on tissues.

In order to avoid the formation of nitric acid it is necessary to use special filters that absorb

nitrogen oxides or use pure oxygen. This complicates the devise design and significantly increases its price.

Another way to produce ozone is photochemical. This method is based on the dissociation of an oxygen molecule under the action of short wave ultraviolet radiation. Synthesis under the influence of ultraviolet radiation is easier to implement and consists in the fact that air is passed through a special chamber where under the influence of short wave ultraviolet irradiation an oxygen molecule dissociates into two atoms and then ozone is formed by adding an atom to oxygen molecule.

An important feature of obtaining ozone using short wave ultraviolet radiation is that under the action of ultraviolet rays occurs no dissociation of nitrogen molecules and nitric acid is not formed [6, 4]. An ozone generator of this type makes it possible to obtain ozone from the air by using short wave ultraviolet radiation and allows us obtain an ozone-air mixture that does not contain nitrogen oxides.

In recent years extensive research has been conducted in the field of periodontology[7,8,9,10,11,12]. New methods of treatment are offered and one of them is ozone therapy. Kislitsina A.V. et al. 2017 used a gas mixture of ozone and air in the treatment of periodontitis [13]. In our opinion it is advisable to use ozonated water as a contact medium when removing dental plaques to enhance the therapeutic effect of procedure [6,14,15].

Aim: To study the effectiveness of dental plaque removal using low frequency ultrasound and an ozonated contact medium obtained from an ozone generator by ultraviolet radiation in the treatment of catarrhal gingivitis of young people.

Materials and methods

The 54 patients aged from 18 to 22 years with a diagnosis of chronic generalized catarrhal gingivitis were examined and treated. All patients were divided into two groups of 27 in each one. The first group was a control group. In this group dental deposits were removed without ozonation of the contact medium. In the second group the removal of dental deposits performed with ozonation of the contact medium obtained from an ozone generator producing ozone by ultraviolet radiation.

The source of low frequency ultrasound vibrations during the removal of dental plaques was the DTE-D7 device. Distilled water was used as a contact medium when removing dental plaques.

For ozonation of the contact medium an ozone generator was used that produced ozone using short ultraviolet radiation. The source of the short ultraviolet radiation was the device “BOP – 01/27”. The device equipped with a compressor for pumping and feeding an ozone-air mixture into a tank with distilled water from a system of diverting and leading silicone tubes [16].

To determine the concentration of ozone at the exit of ozone generator we used a chemiluminescent ozone analyzer 302 PR (Russia). An outflow tube with a working nozzle was placed in the analyzer. As a result of the study it was found that the concentration of ozone directly at the outflow of the nozzle is 0.261 mg/m^3 or 0.000261 mg/l.

Under ozone generator the saturation of the contact medium was up to 10 minutes. The concentration of ozone in ozonated water during the removal of dental plaques was 0.09956 mg/m^3.

The level of hygiene was assessed using the OHI-S (Simplified Green-Vermillion Hygiene Index, 1964). The inflammation severity was assessed using the Papillary Marginal Alveolar Index (PMA). The Papilla Bleeding Index (PBI) used to assess bleeding gums.

Determination of capillary resistance to vacuum was carried out according to the Kulazhenko method using the device for vacuum laser treatment “DESNA”. A vacuum tube of 5.5 ml was applied at the border of alveolar and detached gums in the frontal area of the lower jaw followed by a decrease in pressure to 40 mm of mercury. The resistance of capillaries to vacuum was assessed by the time of hematoma formation.

Rheoparodontography (RPG) was performed on the RPG-2-02 rheoplethysmograph using the tetrapolar technique. The analysis of the rheoparodontogram included a qualitative and quantitative assessment.

Statistical analysis of the obtained data was carried out by the method of variation statistics using the Student's T-test.

Results

Prior to the treatment of chronic

generalized catarrhal gingivitis the main complaints of patients were bleeding gums. The clinical manifestations of inflammation were hyperemia and swelling of the gums. No bone resorption was observed during the X-ray examination. Gum inflammation developed with indicators of OHI-S before treatment 1.94 ± 0.08 in the first group and 2.11 ± 0.11 in the second group. Gum inflammation caused an increase in the PMA index which in the first group was 25.8 ± 0.53 and in the second group 27.2 ± 0.89. The PBI in the first group reached 1.46±0.07 and in the second group 1.52±0.08. Inflammatory phenomena in the gums in both groups developed against the background of a decrease in the resistance of capillaries to vacuum. The time of vacuum hematoma formation on the gum in the first group was 16.1 ± 0.16s and in the second group 15.9 ± 0.07s. Catarrhal gingivitis was accompanied by a disorder in local hemodynamics which consisted in an increase in vascular tone and peripheral resistance while reducing the elasticity of the vascular wall.

Removal of dental plaques in the treatment of catarrhal gingivitis contributed to the relief of symptoms of inflammation and normalization of local blood circulation. At the same time in the second group where ozonated water was used to remove dental plaques there was a more prominent clinical effect compared to the first group where water ozonation was not performed.

Despite the fact that two weeks after the removal of dental plaques the hygiene indices of the first and second groups had no significant differences ($p > 0.05$) and were 0.28±0.03 and 0.26±0.04 respectively, the PMA in the second group was 60% lower than in the first group ($p<0.001$) and the PBI was 41% lower ($p<0.001$). The values of these indices in the first and second groups were PMA 5.3±0.03 and 2.1±0.05; PBI 0.22±0.05 and 0.13±0.02 respectively. At the same time the resistance of capillaries to vacuum in the second group was significantly 7% higher compared to the control group ($p<0.001$). In the first groups 23.6 ± 0.07 s and in the second group 25.3 ± 0.08 s.

Patients in the second group also had a more prominent change in local hemodynamics after removal of dental plaques. Peripheral vascular tone (PVT) was lower by 7% ($p<0.001$), and elasticity index (EI) was higher by 5% ($p<0.001$) compared to the first group.

In the group of patients where ozonated water was used as a contact medium for the removal of dental plaques in the long term after treatment the inflammatory reaction was less pronounced compared to the control group where non-ozonated water was used for the removal of dental plaques and this affected the values of clinical indices. The 3 and 6 months after treatment the values of OHI-S in the first group were 0.51±0.05 and 1.1±0.03; in the second 0.45±0.04 and 0.97± 0.05, respectively. It should be noted that after 3 months the values of this index between the groups had no statistically significant differences ($p>0.05$). At the same time the PMA in the second group 3 months after treatment was lower by 37% and after 6 months by 39% ($p<0.001$) compared to the first group. The values of this index were 11.4±0.04 and 17.2±0.03 in the first group; 7.2±0.02 and 10.5±0.05 in the second group. Gum bleeding according to the PBI after 3 months in the second group was 36% lower and after 6 months by 48% ($p<0.001$) compared with the first control group. The values in the first group were 0.39±0.05 and 0.71±0.05; in the second group 0.25± 0.01 and 0.37±0.03, respectively. The less gum inflammation in the second group was indicated by a longer time of vacuum hematoma formation on the gum. This value was 14% higher in the second group 3 months after treatment and 16% higher in 6 months ($p<0.001$) compared to the first group. The resistance of capillaries to vacuum (IPVR) in the first group 3 and 6 months after treatment 20.9±0.02 and 18.5±0.02; in the second group 23.8±0.08 and 21.4±0.05, respectively.

In the long term after treatment a higher difference in hemodynamic parameters was also observed in the second group compared to the first group. According to rheoparodontography data 3 months after treatment in this group PVT was 8% lower, IPS was 3%, and IE was 5% higher ($p<0.001$) compared to the control group. The 6 months after treatment PVT was 14% lower, index of peripheral vascular resistance (IPVR) was 5% lower and EI was 4% higher ($p<0.001$) compared to the first group.

Thus, the results of this study indicate that dental plaque removal using low frequency ultrasound and an ozonated contact medium obtained from an ozone generator by ultraviolet radiation help to reduce inflammation, normalize local blood circulation in the periodontium, prolong the remission period and stabilize the

process.

Discussion

Ozone therapy has been used in various fields of medicine since the middle of the XX century and is quite widespread, but its clinical application in dentistry has been studied in detail relatively recently. The antimicrobial and antifungal properties of ozone, along with its ability to stimulate the circulatory system and modulate the immune response, make it a useful additional method of treating various infectious diseases of the oral cavity [5].

According to the experimental work of Anongwi Lebanonanthavet, Shinich Arakawa, Shinichi Arakawa, Tokuju Okano, Toshihiko Suzuki (2019), ozone ultrafine bubble water causes stimulation in human periodontal fibroblasts, which is another aspect of the biological role of ozonated water, in addition to its bactericidal activity, in the treatment of periodontal diseases.

The literature data on the application, in particular, of ozonated water in inflammatory diseases of the gum and periodontal are few and contradictory. According to a study by Al Habashneh R, Alsalman W, Khader Y. (2015), irrigation with ozonated water as an additional therapy to SRP does not provide a statistically significant advantage over SRP plus irrigation with distilled water in the examination of 41 patients divided into two groups, the main and control, with periodontitis. These findings are inconsistent with our study. Ozone is effective against oral microorganisms depending on the dose, strain and duration of exposure. In addition, the severity of periodontal diseases plays a role, as well as the method of obtaining ozone and its concentration. To ozonize the contact medium, we used an ozone generator that produces ozone using short ultraviolet radiation. As a result of the study, it was found that the concentration of ozone directly at the exit of the nozzle is 0.261 mg/m3 or 0.000261 mg/l [17].

Removal of dental plaque in the treatment of catarrhal gingivitis contributed to the relief of symptoms of inflammation and the normalization of local blood circulation. At the same time, in the second group, where ozonized water was used to remove dental plaque, there was a more pronounced clinical effect compared to the first group, where water ozonation was not performed. This conclusion is in full agreement with the study by José Cristiano Glória, Dhelfeson Willya Douglas de Oliveira at all (2020) [18]. According to the authors, ozonized water reduced the clinical manifestation of pain, swelling after a complex extraction of the lower third molar. Despite the fact that two weeks after the removal of dental deposits, the indices of the hygiene index of the first and second groups did not have significant differences between themselves ($p > 0.05$) and amounted to 0.28 ± 0.03 and 0.26 ± 0.04, respectively, the PMA index in the second group was 60% lower than in the first group ($p < 0.001$), and the PBI bleeding index was 41% lower ($p < 0.001$).

Patients of the second group also had a more pronounced favorable change in local hemodynamics after removal of dental deposits. PVT was lower by 7% ($p < 0.001$), and EI was higher by 5% ($p < 0.001$) compared to the first group.

In the group of patients where ozonated water was used as a contact medium for the removal of dental deposits, in the long term after treatment, the inflammatory reaction was less pronounced compared to the control group, where non-ozonated water was used for the removal of dental deposits, as evidenced by a change in the values of the indices characterizing inflammation and local blood circulation.

Conclusions

The results of our study showed that the use of ozonated water with the help of short-wave ultraviolet radiation when removing dental deposits in patients with catarrhal gingivitis has an effect on reducing inflammation and causes normalization of microcirculation in periodontal tissues. This effect lengthens the remission period and stabilizes the condition of the gums in chronic generalized catarrhal gingivitis [19, 20].

Declaration of Interest

The authors report no conflict of interest.

References

1.Volkov A.G., Dikopova N.J., Makeeva I.M. et al. Methods of diagnosis and treatment of periodontal diseases and oral mucosa. Textbook. - M.: Published by First Moscow State Medical University named after I.M. Sechenov. 2016:48 p. [In Russian]
2.Sadatulla S., Mohamed N.K., Razak F.A. The antimicrobial effect of ozonized water is 0.1 ppm on a 24-hour in situ plaque of

microorganisms. Braz Oral Res. 2012;26:126-131.
3.Huth K.C., Quirling M., Lenzke S. et al. The effectiveness of ozone against periodontal pathogens. Eur J Oral Sci. 2011;119:204-210.
4.Makeeva I.M., Volkov A.G., Dikopova N.J. et al. Treatment of bisphosphonate necrosis of the jaws with ozone obtained by ultraviolet radiation. Head and neck. Russian edition. All-Russian Public Organization Federation of Specialists in the Treatment of Head and Neck Diseases. 2017;3:73-75. [In Russian]
5.Srinivasan S.R., Amaechi B.T. Ozone: A paradigm shift in dental therapy. J Global Oral Health. 2019;2(1):68-77.
6.Ahmedbaeva S.S., Volkov A.G., Dikopova N.J. et al. Ozone therapy and ultrasound effects in the complex treatment of periodontitis. Russian Dental Journal. 2020;24(2):74-78. [In Russian]
7.Alexandrov M.T., Olesova V.N., Dmitrieva V.N. et al. Problematic issues of assessing the hygienic state of the oral cavity and their clinical solution. Dentistry. 2020;99(4):21-26. [In Russian]
8.Volkov A.G. The use of extremely high frequency electromagnetic radiation (HF therapy) with the complex treatment of periodontitis. PhD diss. Moscow. 1996:22 p. [In Russian]
9.Grudyanov A.I. Materials and methods of prevention of inflammatory periodontal diseases. Moscow. 2012:96 p. [In Russian]
10.Kubishkina K.P., Oleinik O.I., Krasnikova O.P. The use of statistical methods in assessing the treatment effectiveness of chronic periodontitis with the use of ozonated water. Journal of scientific articles: Health and education in the XXI century. 2018;20(5):69-73. [In Russian]
11.Razumova S.N. Dental morbidity in the age aspect. Collection of scientific theses and articles "Health and education in the XXI century". 2006:420 p. [In Russian]
12.Razumova S.N., Brago A.S., Khaskhanova L.M. et al. Modern methods of dental diseases prevention. Medical alphabet. 2018;3(24):69-70. [In Russian]
13.Kislitsina A.V., Volkov A.G., Dikopova N.J. et al. The experience of using ozone therapy in the treatment of periodontitis in instrumentalist musicians. Questions of balneology, physiotherapy and therapeutic physical culture. 2017;94(4):31-34. [In Russian]
14.Volkov A.G., Mihaleva I.N. Physical methods of treatment of periodontal diseases. Problems of dentistry. 2008:210 p. [In Russian]
15.Ikonnikov G.G., Volkov A.G., Volkov E.A. et al. Comparative characteristics of the effect of LED radiation of different wave lengths on the state of microcirculation and oxygenation of periodontal tissues. Russian dentistry. 2016;9(1):90. [In Russian]
16.Volkov A.G., Makeeva I.M., Dikopova N.J. et al. A device for removing dental plaques with ozonation of the contact medium. Patent RU 196560 U1, 04.03.2020. Application No. 2019136770 dated 15.11.2019. [In Russian]
17.Ozone as an adjunct to conventional nonsurgical therapy in chronic periodontitis: a randomized controlled clinical trial R Al Habashneh, W Alsalman, Y Khader - Journal of periodontal research, 2015
18.Carvalho BAS, Duarte CAB, Silva JF, et al. Clinical and radiographic evaluation of the Periodontium with biologic width invasion. BMC Oral Health. 2020;20(1):116. Published 2020 Apr 16. doi:10.1186/s12903-020-01101-x
19. The Prevalence of Caries and Gingivitis in Elementary School Children in Grade IV, V and VI in East Sinjai District Adam M. Hamudeng, Farah Fadhillah. Journal of International Dental and Medical Research 2019; 12 (2)
20. The Clinical Efficacy of A Probiotic Miswak Oral Spray in Patients with Gingivitis. Sherine Nasry, Hanaa Elgamily, Ibrahim El-Refai, Nayra Mehanna. Journal of International Dental and Medical Research 2018; 11 (2)