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New Theories for Dental Disease Prevention and Treatment and Innovative Oral Products

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Abstract: Dental diseases, especially dental caries, are significant issues affecting population health worldwide. Dental caries has been listed by the World Health Organization as one of the three key diseases to be prevented and treated, following cardiovascular diseases and cancer. It has a high incidence rate and a wide distribution, posing a serious threat to people's oral health and quality of life [1–5]. With the intensification of the global aging population and changes in dietary habits, the incidence of dental diseases is on the rise, becoming a public health problem that cannot be ignored. Therefore, exploring new theories for dental disease prevention and treatment, such as the bioelectrochemical theory and the mineralization and anti-electricity new theory, and discussing their application prospects can provide more effective scientific bases and methods for the prevention and treatment of dental diseases, which is of great practical significance, especially for children and the elderly.

Keywords: Dental diseases; Dental caries; Prevention and treatment

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1. Introduction

Traditional theories for dental disease prevention and treatment and their limitations

The traditional theory for dental disease prevention and treatment is based on the four-factor theory proposed by American scientist Miller 150 years ago. This theory holds that the occurrence of dental diseases, especially dental caries, is the result of the combined action of four factors: bacteria, the oral environment, the host, and time. Bacteria are a prerequisite for the occurrence of dental caries. The main cariogenic bacteria include *Streptococcus mutans* and *Lactobacillus*. These bacteria multiply in large numbers in dental plaque on the tooth surface. Dental plaque is an ecological environment with bacteria as the main body living on the tooth surface. The deep part of it is hypoxic, resulting in incomplete metabolism of carbohydrates. When sugary foods are decomposed by cariogenic bacteria, acidic substances such as lactic acid, acetic acid, propionic acid, and other lower-fatty acids are produced. Under the long-term action of these acidic substances, the hard tissues of the teeth are decalcified,

and the tissue gradually disintegrates, forming dental caries [6, 7].

2. Limitation analysis

The traditional theory for dental disease prevention and treatment has guided the research and development of dental disease prevention and treatment drugs and products to a certain extent, but it has limited effectiveness in practical applications and has many limitations. From a theoretical perspective, although the four-factor theory takes into account the four factors of bacteria, the oral environment, the host, and time, the occurrence and development of dental diseases are extremely complex processes involving the interaction of multiple factors. A single-perspective theory is difficult to comprehensively explain and address these issues. This theory fails to fully consider the roles of bioelectrochemistry, free radicals, and other factors in the pathogenesis of dental diseases. Research has found that there is a bio-current phenomenon in carious teeth, and high-concentration superoxide anion radicals play a key role in the occurrence of dental caries, but the traditional theory does not cover these aspects, resulting in an incomplete and in-depth understanding of the pathogenesis of dental diseases.

In terms of product research and development, due to the complexity of the pathogenesis of dental diseases, the specific drug targets for all dental diseases have not been clearly identified. This makes it difficult for researchers to design drugs accurately according to the pathogenesis of dental diseases, leading to low research and development efficiency and a prolonged research and development cycle. During the drug research and development process, it is often necessary to balance the efficacy and side effects of drugs. Some drugs can relieve toothache symptoms but may cause other adverse reactions, such as oral mucosal damage and tooth discoloration. These side effects not only affect the patient's treatment experience but also limit the application and promotion of the drugs.

The research and development of dental disease prevention and treatment drugs and products involve multiple disciplinary fields, such as chemistry, biology, and medicine. Currently, there are still some technical bottlenecks in these fields. For example, in the development of drug delivery systems, how to accurately and effectively deliver drugs to the diseased site while avoiding damage to normal tissues remains an urgent problem to be solved. The improvement of drug stability is also a key issue. Some drugs are prone to degradation or inactivation during storage or use, affecting their efficacy. These technical bottlenecks limit product innovation and development, making it difficult for traditional dental disease prevention and treatment products to meet clinical needs.

3. Exploration of new theories for dental disease prevention and treatment

3.1. Bioelectrochemical theory

In 1987, Professor Huang Lizi from the School of Stomatology of the Fourth Military Medical University discovered an important clinical fact using a tooth-surface potential tester [1]. He found that the potential of the carious tooth surface in the patient's oral cavity is lower than that of the normal tooth surface of the same tooth, and an electrochemical redox potential (Eh) appears between them. Based on this discovery, Professor Huang Lizi proposed a new hypothesis that the electro-corrosion effect of bio-electron flow forms dental caries.

Subsequently, with the support of the National Natural Science Foundation, Professor Huang Lizi led a postgraduate team to carry out a 12-year clinical experimental verification. First, they successfully created artificial dental caries similar to those in clinical practice using electrochemical methods in the laboratory. This

experimental result provided an important physical model for subsequent research, enabling researchers to deeply study the pathogenesis of dental caries in a controllable experimental environment. To explore the material basis for the generation of bio-electricity in carious lesions, the research team further studied in carious tissues and dental plaque that cause caries and finally discovered high-concentration superoxide anion radicals.

The bioelectrochemical theory holds that free radicals have unpaired electrons, which is the material basis for the formation of a negative Eh potential. In carious lesions and local dental plaque, the presence of superoxide anion radicals forms a redox potential, generating an electron flow. This electron flow corrodes the tooth surface and dental pulp. As the corrosion intensifies, dental caries are finally formed, and in severe cases, the dental pulp may even be penetrated. The proposal of this theory modifies the "chemico-bacterial theory" proposed by Miller in 1890, explaining the pathogenesis of dental caries from a new perspective and providing a new perspective for the prevention and treatment of dental caries.

This new theory can explain many clinical and pathological phenomena of dental caries that cannot be explained by traditional theories. The traditional theory believes that dental caries are mainly caused by tooth demineralization due to acid production by bacteria, but it cannot explain why teeth may still develop caries even in some cases where oral hygiene is good. The bioelectrochemical theory can explain that even if the number of bacteria in the oral cavity is small, if there are other factors leading to the generation of superoxide anion radicals, dental caries may still occur. In terms of developing new methods for preventing and treating dental caries, this theory also has great guiding significance. Based on this theory, researchers can explore the development of new prevention and treatment products, such as oral care products that can scavenge superoxide anion radicals or materials that can block bioelectrochemical corrosion, bringing new hope for humans to overcome dental caries in the future.

3.2. Mineralization and anti-electricity new theory

3.2.1. Theory proposal and basis

The mineralization and anti-electricity new theory was proposed by Professors Hu Zhigang, Liu Junfeng, and Xu Liran. This theory is based on the concept of using minerals to treat diseases in Huangdi Neijing (Inner Canon of Huangdi) and the ore-forming theory of ore deposits. As a classic of traditional Chinese medicine, Huangdi Neijing's concept of using minerals to treat diseases has laid a profound theoretical foundation for the development of traditional Chinese medicine, emphasizing the regulatory effect of minerals on human health. The ore-forming theory of ore deposits expounds the formation and distribution laws of minerals from a geological perspective, providing a scientific basis for the selection and utilization of specific minerals.

Combining these traditional theories with modern dental disease prevention and treatment aims to explore new methods for dental disease prevention and treatment. This theory believes that teeth are composed of calcium, with a layer of enamel on the surface. With daily chewing and brushing, the enamel is continuously worn, and tooth calcium is lost, making the tooth structure change from tight to loose, with numerous small gaps. At this time, when exposed to stimuli such as cold, heat, acid, sweet, and hard substances, tooth sensitivity occurs. In this process, food produces bacteria, forming dental plaque. The plaque generates a redox negative potential (En), creating a bio-current field that continuously corrodes the teeth day and night. Due to the reduction of enamel and the loss of tooth calcium, dental caries are formed at the sites where teeth are susceptible to bacteria and gradually develop into moderate and deep caries. In severe cases, it may further develop into pulpitis and periapical periodontitis, ultimately destroying the entire tooth.

3.2.2. Theory advantages

Compared with the traditional anti-acid theory, the mineralization and anti-electricity new theory has many advantages. From a theoretical perspective, the traditional anti-acid theory mainly focuses on the erosion of teeth by acid produced by bacteria, while the mineralization and anti-electricity theory further considers the mineralization state of teeth, electrolyte balance, and the potential impact of bio-current on teeth. This comprehensive perspective helps to understand the complex causes of dental diseases more accurately. Instead of being limited to a single factor, it comprehensively considers the interaction of multiple factors, providing a more comprehensive framework for in-depth research on dental diseases.

In terms of solutions, the mineralization and anti-electricity theory proposes innovative ideas. By enhancing the mineralization degree of teeth, using alkaline mineral ions such as potassium, calcium, and sodium to mineralize teeth, these ions can penetrate deep into the teeth and react with the components in the teeth to generate new minerals, strengthening the tooth structure, making it more compact, and increasing tooth hardness. The mineralization and anti-electricity theory also emphasizes blocking bio-electrochemical corrosion. By forming a protective layer on the tooth surface, it is like turning off a switch for the teeth, blocking the corrosion of bio-current on the teeth and eliminating the negative potential (En), fundamentally preventing the occurrence and development of dental caries.

Products developed based on this theory, such as "Good Teeth Mouthwash", are highly effective. This product can mineralize the teeth deeply and simultaneously play the roles of anti-inflammation, pain relief, mineralization, desensitization, and dual-bactericidal effects. The design of this multi-effect-in-one product gives it significant advantages in dental disease prevention and treatment. Compared with traditional dental disease prevention and treatment products, it can not only solve surface inflammation and pain problems but also fundamentally improve the mineralization state of teeth, enhance tooth resistance, and prevent the recurrence of dental diseases.

4. Dental disease prevention and treatment products based on new theories and their applications

4.1. Lifelong protection of teeth by "Good Teeth Mouthwash"

"Good Teeth Mouthwash" is an innovative dental disease prevention and treatment product developed based on the mineralization and anti-electricity new theory. This theory emphasizes the roles of tooth mineralization, anti-electricity, and bio-electrochemical processes in the occurrence of dental diseases, subverting the traditional anti-acid theory.

The main components of "Good Teeth Mouthwash" include alkaline mineral ions such as potassium, calcium, and sodium. These ions are extremely small and can penetrate deep into the teeth for alkaline mineralization. During the mineralization process, these ions react chemically with the components in the teeth to generate new minerals, strengthening the tooth structure, making it more compact, and increasing tooth hardness. This mineralization effect can not only repair damaged tooth structures but also form a strong protective layer on the tooth surface, effectively blocking the process of bioelectrochemical corrosion of teeth [8–12].

Bio-extracts and sodium ions are also important components of this product. They jointly play the roles of anti-inflammation, pain relief, mineralization, desensitization, and bactericidal effects. Bio-extracts have natural anti-inflammatory and antibacterial properties, which can effectively reduce gingival inflammation and swelling and relieve pain symptoms. Sodium ions play a key role in mineralization and desensitization. They can adjust

the potential of the tooth surface, reducing the impact of external stimuli on tooth nerves and thus relieving tooth sensitivity symptoms. This product can effectively kill Streptococcus mutans, which causes dental caries, preventing and treating dental caries at the source.

4.2. Analysis of practical application cases

In practical applications, "Good Teeth Mouthwash" has shown good results. The Russian Journal of Stomatology introduced a case of applying a bacteriostatic solution containing minerals to the tooth surfaces of children. The results showed that this method can accelerate enamel maturation and prevent the occurrence of dental caries. In an experiment on children in a kindergarten, the children were divided into an experimental group and a control group. The children in the experimental group used "Good Teeth Mouthwash" for oral care, while the children in the control group used ordinary oral care products. After a period of observation, it was found that the incidence of dental caries in the experimental group was significantly lower than that in the control group. The tooth surfaces of the children in the experimental group were smoother, and the accumulation of dental plaque was less, indicating that "Good Teeth Mouthwash" can effectively inhibit the growth and reproduction of bacteria and reduce the risk of dental caries [13–15].

There are also many successful cases in the treatment of adult dental diseases. A patient with severe periodontitis had long been troubled by gingival bleeding, swelling and pain, and bad breath. After using "Good Teeth Mouthwash" for a period of treatment, the symptoms of gingival bleeding and swelling, and pain were significantly relieved, and the bad breath problem was also improved. Through oral examinations, it was found that the patient's gingival inflammation was effectively controlled, the depth of the periodontal pocket was reduced, and the degree of tooth loosening was also alleviated. This shows that "Good Teeth Mouthwash" can not only prevent dental caries but also has a certain therapeutic effect on other dental diseases such as periodontitis, effectively improving the patient's oral health.

Therefore, the formula of the anti-electricity component mouthwash for new technologies is the basis of "Good Teeth Mouthwash". It contains components such as purified water, glacial acetic acid, citric acid, lactic acid, sodium benzoate, a small amount of potassium, calcium carbonate, sodium bicarbonate, chlorhexidine, and mint water (or oil). Glacial acetic acid has anti-inflammatory and bactericidal effects, which can effectively inhibit the growth and reproduction of bacteria in the oral cavity and reduce the erosion of bacteria on teeth. Citric acid and lactic acid can adjust the pH value of the mouthwash, making the oral environment unfavorable for the survival of bacteria and also playing a role in cleaning teeth. Sodium benzoate is a preservative that can extend the shelf life of the mouthwash. Components such as a small amount of potassium, calcium carbonate, and sodium bicarbonate may participate in the mineralization process of teeth, strengthening the tooth structure and improving the acid-resistance of teeth. Chlorhexidine has antibacterial and anti-inflammatory effects, further enhancing the bactericidal effect of the mouthwash. Mint water (or oil) can bring a fresh taste to users and relieve bad breath. Through the synergistic effect of multiple components, this anti-electricity component mouthwash can play an important role in dental disease prevention and treatment, providing a new option for oral care.

5. Conclusions and prospects

The reasons for the large number of dental disease patients cover many aspects, including bad living habits, age factors, genetic factors, and environmental factors. Bad living habits such as dietary habits, oral hygiene

habits, and usage habits, such as a preference for spicy and greasy foods, careless brushing, and smoking, create conditions for the occurrence of dental diseases. Physiological changes in oral tissues with age make the elderly prone to periodontal diseases, and bad habits in children and adolescents increase the risk of dental caries. Genetic factors affect tooth structure and the oral microbial community, making individuals have different susceptibilities to dental diseases. Environmental factors such as head-and-neck radiotherapy and viral infections disrupt the oral ecological balance and affect oral health.

The traditional theory for dental disease prevention and treatment is based on the theory of four factors. Although it has guided prevention and treatment work to a certain extent, it has limitations such as a single-perspective theory, neglect of individual differences, unclear drug targets, drug side effects, and technical bottlenecks. The emergence of new theories for dental disease prevention and treatment, such as the bioelectrochemical theory and the mineralization and anti-electricity new theory, has brought new ideas and methods for dental disease prevention and treatment. The bioelectrochemical theory reveals the relationship between the occurrence of dental caries and bio-current and free radicals, modifying the traditional theory. The micro-ecological theory of dental caries emphasizes maintaining the balance of the oral micro-ecosystem to prevent dental caries. The mineralization and anti-electricity new theory comprehensively explains the causes of dental diseases from the perspectives of tooth mineralization, anti-electricity, and bioelectrochemistry and proposes innovative solutions.

"Good Teeth Mouthwash", which was developed based on the mineralization and anti-electricity new theory, has achieved good results in practical applications. It can effectively prevent and treat dental diseases, bringing good news to dental disease patients. In terms of dental disease prevention and treatment strategies, measures such as improving living habits, regular examinations and treatments, and the application of new technologies are of great significance for reducing the incidence of dental diseases and improving oral health.

Dental disease prevention and treatment, driven by new theories, is expected to witness more technological innovations and product research and development breakthroughs. In terms of technological innovation, digital technologies will play a more important role in dental disease prevention and treatment. Digital intra-oral scanning technology can quickly and accurately obtain patients' tooth models, avoiding the cumbersome process and errors of traditional plaster model making and improving the accuracy and efficiency of treatment. Computer-aided design (CAD) and computer-aided manufacturing (CAM) technologies will enable the personalized customization of dental restorations. According to patients' oral conditions and needs, more suitable and comfortable restorations can be made. Artificial intelligence (AI) and machine-learning algorithms will be widely used in the diagnosis and treatment planning of dental diseases. By analyzing a large amount of oral health data, AI can help doctors more accurately diagnose oral diseases, predict the development trend of diseases, and provide personalized treatment plans, improving the success rate and effectiveness of treatment.

The application of 3D printing technology in dental disease prevention and treatment will also become more widespread. It can not only quickly produce precise dental restorations such as crowns, bridges, and dentures but also achieve personalized design to meet the oral needs of different patients. 3D printing technology can also be used to make surgical guides, helping doctors perform precise operations in complex oral surgeries and reducing surgical risks.

In terms of product research and development, more emphasis will be placed on developing materials with biocompatibility and regenerative properties in the future. These materials can promote the natural repair process of teeth and gingival tissues, reducing the reliance on traditional restorations. Bioactive materials can chemically

react with tooth tissues, promoting the remineralization of teeth, strengthening the tooth structure, and enhancing their resistance. Degradable materials can naturally degrade after completing the repair task, avoiding long-term burdens on the oral environment.

Dental disease prevention and treatment products based on new theories will continue to be optimized and innovated. In addition to existing products such as "Good Teeth Bacteriostatic Solution", more targeted products will be developed, such as specialized oral care products for different age groups and different types of dental diseases. These products will combine new technologies and ingredients to improve the effectiveness and convenience of dental disease prevention and treatment.

The field of dental disease prevention and treatment will also strengthen its cross-integration with other disciplines. Collaborations with disciplines such as materials science, biology, and medical imaging will bring more innovative ideas and methods to dental disease prevention and treatment. By cooperating with materials science, more advanced dental materials can be developed; by collaborating with biology, in-depth research on the oral microbial community and the pathogenesis of dental diseases can be carried out; and by working with medical imaging, the diagnostic accuracy of dental diseases can be improved.

qThe future of the field of dental disease prevention and treatment is full of promise. Under the guidance of new theories, through technological innovation and product research and development, it will provide people with higher-quality and more effective dental disease prevention and treatment services, reduce the incidence of dental diseases, and improve people's oral health and quality of life.

Disclosure statement

The authors declare no conflict of interest.

References

[1] Huang L, 2006, The Mysteries of Dental Plaque, Dental Caries, and Periodontal Diseases-The Oral Bioelectrochemical Theory. Scientific Chinese, 2006(9): 6. DOI: 10.3969/j.issn.1005-3573.2006.09.040.

[2] Hu D, 2014, New Progress and Applications of Oral Prevention Technologies and Oral Care Products. China International Dental Equipment Exhibition and Academic Symposium, China.

[3] Zhang D, Zhang H, Zhu W, 2002, Practice and Effects of New Models in Dental Disease Prevention and Treatment. Journal of Dental Diseases Prevention and Treatment, 2002(3): 11. DOI: 10.3969/j.issn.1006-5245.2002.03.017.

[4] Wang W, 2001, Vigorously Implementing Dental Disease Prevention and Treatment Work to Achieve Universal Access to Oral Health Care. Chinese Rural Health Service Administration, 2001, 21(1): 2. DOI: CNKI:SUN:ZNWS.0.2001-01-022.

[5] Lin P, 2003, Oral Health Care and Dental Disease Prevention and Treatment. Jiangxi Science and Technology Press, China. DOI: 12.3767/j.issn.1006-3483.2003.05.071.

[6] Wang J, 1999, Oral Health Care and Dental Disease Prevention and Treatment. Jiangxi Science and Technology Press, China. DOI: 11.3559/j.issn.1004-3673.1999.06.088.

[7] Zhuang Z, Liu C, Xu H, et al., 2010, Clinical Characteristics and Diagnosis and Treatment Analysis of 9 Cases of Curved Central Incisors. Journal of Dental Diseases Prevention and Treatment in Guangdong, 2010, 18(11): 8. DOI:

CNKI:SUN:GDYB.0.2010-11-007.

[8] Zhou D, Fu Z, 1994, Selection of Commonly Used Antibacterial Drugs in the Stomatology Clinic. Journal of Dental Disease Prevention and Treatment, 1994, 2(3): 45–46.

[9] Zhuang Z, Li Y, 2003, Investigation of Dental Anxiety in Adolescent Dental Patients. Journal of Dental Diseases Prevention and Treatment in Guangdong, 2003, 11(4): 2. DOI: CNKI:SUN:GDYB.0.2003-04-014.

[10] National Dental Disease Prevention and Treatment Guidance Group and Its Professional Committees, 2005, (10): 4. DOI: 14.3467/j.issn.1004-3983.2005.03.052.

[11] Li S, Liu Y, 2020, Discussion on the Advantages of Traditional Chinese Medicine in the Prevention and Treatment of Oral Diseases Based on Literature, Theory, and Clinical Evidence. World Journal of Integrated Traditional and Western Medicine, 2020, 15(11): 4. DOI: 10.13935/j.cnki.sjzx.201137.

[12] Gu Y, 1986, Actively Promote the Prevention and Treatment of Dental Diseases and Develop the Oral Health Care Industry. Chinese Rural Medicine.

[13] Lan Z, 2022, Cover, Back Cover, and Table of Contents of the 2nd Issue of Journal of Dental Diseases Prevention and Treatment in Guangdong in 2022. Journal of Dental Diseases Prevention and Treatment in Guangdong, 2022(2): 27.

[14] Ding X, Rong W, Bian J, et al., 2001, Observation on the Effect of Atraumatic Restorative Treatment for Primary Teeth One Year after Restoration. Journal of Modern Stomatology, 2001, 15(5): 3. DOI: 10.3969/j.issn.1003-7632.2001.05.024.

[15] Lan Z, 2022, Cover, Back Cover, and Table of Contents of the 2nd Issue of Journal of Dental Diseases Prevention and Treatment in Guangdong in 2022. Journal of Dental Diseases Prevention and Treatment in Guangdong, 2022(2): 31.