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Prevention and treatment of periodontal diseases in patients with type 2 diabetes (literature review)

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Abstract: The review article analyzes current approaches to the prevention and treatment of periodontal diseases in patients with type 2 diabetes. Key pathogenetic mechanisms are discussed, including microcirculatory disorders, an imbalance of pro-inflammatory and anti-inflammatory cytokines, oxidative stress, and delayed tissue regeneration. Local therapies such as antimicrobial agents, phytopreparations, and innovative drug compositions are examined alongside systemic approaches involving immunomodulators, hypoglycemic agents, and physiotherapeutic methods. The significance of comprehensive therapy aimed at improving metabolic control and preventing the progression of pathological changes in periodontal tissues is emphasized. Data on the effectiveness of various treatment methods, including laser therapy, hyperbaric oxygenation, and balneotherapy, are presented.

Keywords: Type 2 diabetes, periodontal diseases, pathogenesis, local therapy, systemic therapy, immunomodulators, phytopreparations, laser therapy, hyperbaric oxygenation, comprehensive therapy.

Introduction: Periodontal diseases in patients with type 2 diabetes represent a significant clinical challenge due to the unique interplay between metabolic dysfunction and inflammatory processes. The pathogenesis is characterized by microcirculatory impairments, dysregulation of cytokine profiles, oxidative stress, and delayed tissue repair. These factors contribute to the rapid progression of periodontal destruction and

diminished therapeutic response.

Despite advancements in treatment modalities, the management of periodontal diseases in this patient population remains suboptimal. Local therapies, including antimicrobial agents and phytopreparations, have demonstrated limited efficacy without addressing systemic metabolic alterations. Systemic approaches, such as the use of hypoglycemic agents and immunomodulators, require further refinement to target the multifactorial nature of periodontal pathology.

This review provides an in-depth analysis of current preventive and therapeutic strategies for managing periodontal diseases in individuals with type 2 diabetes. The focus is on evaluating the efficacy of local and systemic interventions, identifying gaps in clinical protocols, and outlining the potential of innovative methods, such as laser therapy and hyperbaric oxygenation, in improving outcomes. The goal is to establish a foundation for evidence-based approaches that address both periodontal health and metabolic control in this high-risk group.

METHODS

The methodology of this review was based on the systematic collection and critical analysis of peer-reviewed studies addressing the prevention and treatment of periodontal diseases in patients with type 2 diabetes. The literature search was conducted using databases such as PubMed, Scopus, and Web of Science, focusing on publications from 2000 to 2023. Specific search terms included "type 2 diabetes," "periodontal therapy," "local and systemic treatment," "microcirculation," and "cytokine imbalance."

Only studies meeting predefined criteria were included in the analysis. These criteria encompassed clinical and experimental research providing robust evidence on therapeutic approaches, preventive measures, or pathophysiological insights specific to periodontal diseases in patients with type 2 diabetes. Publications with ambiguous methodologies or lacking relevance to the topic were excluded.

All eligible studies were evaluated for their methodological quality, sample size, and statistical reliability. Particular attention was given to data on the effects of local therapies, such as antimicrobial agents and innovative drug formulations, and systemic treatments involving hypoglycemic agents, immunomodulators, and physiotherapeutic techniques. Studies utilizing advanced interventions, including laser therapy and hyperbaric oxygenation, were analyzed to understand their impact on periodontal and systemic outcomes.

The extracted data were organized to reflect the clinical and biological efficacy of each approach. Emphasis was placed on identifying patterns in treatment effectiveness, limitations, and the relationship between periodontal health and glycemic control. This methodology provided a comprehensive foundation for evaluating current practices and outlining evidence-based strategies for managing periodontal diseases in the context of type 2 diabetes.

Literature Review

This complexity arises from the frequent recurrence of inflammatory processes in periodontal tissues, rapid progression of the disease, delayed tissue regeneration following treatment, and resistance to standard therapeutic approaches in this patient group (Mokhort E.N., 2000; Ibragimov T.N. et al., 2004; Efremov O.S., 2007; Reva G.V. et al., 2011; Barmasheva A.A. et al., 2014). According to S.N. Parunova (2004), postoperative complications following reconstructive surgery exceed 52% in type 1 diabetes patients, 42% in type 2 diabetes, while in somatically healthy individuals, these complications remain below 12%.

The metabolic disorders, vascular abnormalities, and immunological responses characteristic of diabetes exacerbate the progression of periodontal diseases. Standard treatments often fail to yield satisfactory outcomes in diabetic patients, as dental practitioners typically employ conventional methods that do not account for localized and systemic changes, both in the oral cavity and the body as a whole. Furthermore, endocrinologists seldom adhere to regular referrals of patients for preventive dental examinations and rarely emphasize the importance of oral hygiene. As a result, conservative local treatments are predominantly applied, while surgical interventions are avoided due to the heightened risk of complications caused by the underlying disease, making comprehensive treatment particularly challenging (Bogomolov M.V., 2011; Zyryanov B.N. et al., 2014).

Research by F.Y. Daurova et al. (2013) demonstrated that traditional local anti-inflammatory therapy significantly reduces levels of pro-inflammatory cytokines IL-1β and IL-6 compared to baseline values before treatment. Although anti-inflammatory IL-4 levels approached control values, the persistently high levels of pro-inflammatory cytokines indicate insufficient immunocorrective effects of traditional

therapy. This limitation suggests that such treatments fail to fully restore the optimal balance between pro- and anti-inflammatory cytokines. In contrast, comprehensive therapy incorporating the hypoglycemic agent gliclazide, which modulates cytokine balance, resulted in faster resolution of inflammatory processes in periodontal tissues among diabetic patients compared to local anti-inflammatory treatment alone.

The tendency of periodontal tissues toward purulent-necrotic processes and productive inflammation in patients with type 1 diabetes, particularly under conditions of poor glycemic control, underscores the necessity of specific immunomodulatory and antibacterial therapy as well as the use of hemostatic agents (Tsepov L.M. et al., 2008).

For local treatment of periodontal pockets, T.M. Elovikova (1989) proposed using yarrow infusion and a 3-5% aqueous solution of Eleutherococcus as agents with anti-inflammatory, hypoglycemic, adaptogenic, antitumor, and enzymatic activity-stimulating properties.

To normalize carbohydrate metabolism, herbal decoctions (blueberry leaves, immortelle flowers, dandelion root, buckthorn bark), vitamin B1, ascorbic acid, and nicotinic acid have been recommended (Alexandrov E.I., 2011).

Combinations of insulin with other agents are widely used for local therapy, including irrigation of periodontal pockets with insulin and dimexide, and the application of zinc-insulin suspension (40 units per 1 ml) combined with antibiotics (0.2–0.3 g) or a clotrimazole-troxerutin-insulin paste. Clotrimazole in the paste provides broad-spectrum antifungal and antimicrobial effects, while troxerutin acts as an angioprotector, reducing capillary fragility and permeability (Elovikova T.M., 1989; Danilevsky N.F., Borisenko A.V., 2000; Tsepov L.M. et al., 2008). When combined with direct antioxidants, this paste delivers significant clinical effects, including faster glucose normalization, decreased lipid peroxidation, and enhanced antioxidant tissue capacity (Yanushevich O.O., 2002; Alexandrov E.I., 2011).

Danilevsky N.F. and Borisenko A.V. (2000) applied periodontal dressings comprising zinc-insulin suspension (40 units per 1 ml), sodium nucleinate (0.2 g per 1 ml suspension), and white clay to achieve the required consistency. These dressings were combined with broad-spectrum antibiotics, nitrofurans, antifungal, and antiparasitic agents.

According to the method proposed by A.I. Grudyanov and I.V. Bezrukova (2000), periodontal treatment in diabetic patients includes the elimination of local factors, intensive anti-inflammatory therapy, scaling and root planing of periodontal pockets, and systemic therapy with agents promoting collagen and bone tissue regeneration, such as vitamin C, fluoride preparations (2% sodium fluoride solution or fluoride varnish), and keratoplastic substances. However, fluoride compounds lack the microcirculatory and osteoinductive properties exhibited by calcium-phosphate-based treatments, such as hydroxyapatite.

The use of the medical product "HAG-BOL" for secondary prevention of chronic generalized periodontitis in patients with type 1 diabetes has been described by Y.B. Belousova (2010). "HAG-BOL" is a gel introduced into periodontal pockets after scaling. It contains 2% chitosan ascorbate, chondroitin sulfate, hyaluronic acid, heparin, bovine serum growth factor, 4% sodium alginate, and 50% amorphous hydroxyapatite. According to the authors, this approach enhances treatment efficacy by reducing inflammation, improving blood supply, halting soft and hard tissue destruction, and decreasing tooth mobility.

E.A. Mikheeva (2003) demonstrated the effectiveness of "Xidiphon" in the comprehensive treatment of periodontal diseases in patients with type 2 diabetes. The drug reduces calculus formation, exerts significant anti-inflammatory effects, and normalizes microcirculation in affected periodontal tissues.

Plant-based medicines are extensively used in periodontology due to their mild action, low toxicity, and minimal allergenic potential compared to synthetic drugs. They also exhibit high bioavailability and are easily incorporated into tissue metabolism. The most therapeutically active components in plants are water-soluble biologically active substances such as phytoenzymes, phytohormones, and polysaccharides (Melnychuk G.M., 2002; Banchenko G.V. et al., 2007). High efficacy has been noted for "Urolesan" (a composition based on wild carrot seeds, spruce, mint, hop cones, and oregano) (Kazakova R.V. et al., 2002) and the phytocomplex "Spirulin with Jerusalem artichoke" (Melnychuk G.M., 2002).

The studies by M.V. Kozodaeva (2012) demonstrated high efficacy of phytopreparations ("CM," "Tonzinal," and "Meglizal") in the comprehensive treatment of chronic periodontitis in patients with diabetes mellitus. The application of these medications resulted in pronounced clinical improvements, restoration of local immune parameters, re-establishment of interrelations

among immune components, and normalization of oral microbiota composition.

Research by M.A. Amkhadova et al. (2014) revealed that tooth depulpation in cases of grade II tooth mobility, combined with systematic individual hygiene and the use of licorice oil phytopreparation, which exhibits strong anti-inflammatory and antibacterial properties, positively affected the microbial load in periodontal pockets. This approach reduced the presence of Staphylococcus aureus, Peptococcus, B. forsythus, Escherichia coli, and Candida albicans, decreased the overall microbial count of streptococci, staphylococci, and odontogenic bacteroides, and improved the effectiveness of ultrasonic scaling in patients with type 2 diabetes.

The use of the therapeutic and prophylactic toothpaste “Parodontax,” based on plant-derived ingredients, in patients with compensated type 2 diabetes resulted in a more significant reduction in periodontal inflammation and gum bleeding compared to non-anti-inflammatory toothpaste. The effect was enhanced when combined with the “Parodontax” balm rinse (Orekhova L.Y. et al., 2013).

For local periodontal therapy in diabetic patients, a therapeutic composition comprising propolis tincture, metronidazole, tea tree oil, fennel oil, and sea buckthorn oil has been proposed. This combination accelerates reparative processes, reduces the microbial colonization of periodontal tissues by periodontopathogenic microorganisms, and normalizes metabolic processes without inducing habituation or allergic reactions and other adverse effects (Alexandrov E.I., 2011).

The use of homeopathic remedies, such as "Traumeel S," has been identified as a promising direction for periodontal treatment in diabetic patients (Vavilova T.P. et al., 2006).

Xerostomia is among the earliest and most common oral manifestations of diabetes mellitus, characterized by increased thirst, appetite, catarrhal inflammation, dryness of the oral mucosa, increased saliva viscosity, and reduced lysozyme, alpha-amylase, and peroxidase activities. The therapeutic use of the "BioXtra" system, containing enzymes analogous to those in natural saliva, is justified. Incorporating "BioXtra" products into preventive programs for diabetic patients with xerostomia has been shown to decrease the prevalence of major periodontopathogens, improve oral hygiene, enhance mixed saliva secretion rates, reduce viscosity, increase alpha-amylase and peroxidase activities, and lower saliva pH (Dovidenko A.B., 2008, 2010).

According to T.M. Elovikova et al. (2013), the use of the oral rinse "Asepta" after a course of treatment significantly improved the microcrystalline structure of oral fluid, increased salivation, and enhanced oral cavity cleanliness in hospitalized patients with type 2 diabetes.

Local antimicrobial therapy for patients with diabetes mellitus includes a range of agents, such as chlorhexidine digluconate, etonium, dioxidine, miramistin, decasan, "Lizobact," "Stomatidin," xidiphon, indomethacin, metronidazole, "Metrogyl-Denta," and "Paragel." Since periodontal pathogens are predominantly anaerobic microorganisms, the use of oxygen-releasing antiseptics is recommended for local treatment of periodontal diseases. These include a 1–3% hydrogen peroxide solution and a 0.25% potassium permanganate solution. Additionally, hydrogen peroxide enhances local leukocyte activity and exhibits significant hemostatic effects (Ostromenetskaya T.K., 2003; Alexandrov E.I., 2011).

In the context of spa therapy, M.V. Martyusheva (2007) recommended incorporating a course of balneotherapy with hydrogen sulfide mineral water into the comprehensive treatment of chronic generalized periodontitis of varying severity in patients with type 2 diabetes. The use of hydrogen sulfide mineral water from the "Klyuchi" resort was associated with a reduction in microbial colonization of gingival pockets, decreased virulence of microflora, improved differentiation of epithelial cells, and enhanced hemodynamics.

Physiotherapeutic methods are widely employed as part of comprehensive therapy (Slonova V.M. et al., 2004). Hyperbaric oxygenation has proven highly effective in managing diabetes-related periodontal conditions (Efremov O.S., 2007; Alexandrov E.I., 2011), as has low-intensity laser therapy (Alexandrov E.I., 2011; Pejcic A. et al., 2010; Obradović R. et al., 2011, 2013).

In dental practice, laser therapy provides numerous benefits, including normalization of microcirculation, stimulation of metabolic processes, anti-inflammatory effects, and analgesia. Intravenous laser blood irradiation has a multifaceted impact on the body, enhancing immunity, improving gas exchange and resistance to hypoxia, facilitating oxygen utilization in tissues, and normalizing lipid peroxidation. Furthermore, laser therapy optimizes microcirculation, rheological and anticoagulant blood properties, and activates the fibrinolytic system, reducing platelet

adhesiveness and aggregation.

Research by S.I. Vyrmaskin et al. (2015) demonstrated the positive effects of erbium dental lasers on the capillary vascular network in periodontal tissues, supported by histological findings.

A significant component of comprehensive periodontal treatment, particularly for aggressive forms of the disease, is oral hygiene and maintenance therapy. According to I.V. Bezrukova (2004), patients often lack sufficient motivation for proper oral hygiene and regular dental visits, with the effects of individual education persisting for a short period, typically 1.5 to 3 months. Regular monitoring of oral hygiene, repeated instruction on hygiene methods and products, and clear communication about the importance of thorough oral care are therefore essential. Tooth hypersensitivity, a common symptom of periodontal diseases, including those associated with diabetes, often leads patients to avoid brushing, worsening oral hygiene and exacerbating periodontal disease severity. The use of desensitizing toothpastes and rinses, such as "Sinqvel Active" and "Sinqvel Sensitive," has been shown to be beneficial for diabetic patients (Khomrova E.A., Moroz B.T., 2009).

Microcirculatory changes associated with diabetes significantly affect the development and progression of oral diseases, necessitating the inclusion of hemodynamic correction as part of etiological treatment (Garagan S.F., 2005). R.S. Musaeva (2009) reported that 100% of examined diabetic patients showed marked periodontal microcirculatory disturbances based on ultrasound Doppler imaging.

Specialized toothpastes, such as "Mexidol-Active" and "Diadent-Active," have been shown to improve clinical conditions and microcirculation in the periodontal tissues of diabetic patients with inflammatory diseases. Adding oral hygiene measures with systemic administration of tablet-form Mexidol reduces oxidative stress, restores macro- and microelement balance in biological media by reducing calcium overload, replenishing deficiencies of magnesium, zinc, and, in some cases, copper, and exhibits cytoprotective effects. These benefits improve cellular viability and resistance to damage, as evidenced by a significant reduction in erythrocyte sensitivity to photohemolysis. The systemic metabolic effects and multifactorial homeostatic corrections associated with Mexidol contribute to its role in pathogenetic treatment of inflammatory periodontal diseases in diabetic patients (Orekhova L.Y. et al., 2008, 2009; Musaeva R.S., 2009).

For the systemic treatment of macrovascular changes, including those affecting periodontal tissues, combinations of drug groups targeting various pathogenic pathways are prescribed. These include rheocorrectors (hemodez, reopolyglucin) to normalize blood rheology, agents improving tissue oxygenation (solcoseryl), and drugs reducing the aggregation of blood elements (trental, curantyl). Angioprotectors (doxium, prodektin, aninin, dicynone), membrane protectors (essentiale, tocopherol), and antiplatelet agents are also widely used in the treatment of vascular pathology in diabetic patients. A promising direction in the treatment of diabetic angiopathies is the use of enzyme blockers of the sorbitol pathway of glucose metabolism, such as aldose reductase and sorbitol dehydrogenase inhibitors, including isodibut (Alexandrov E.I., 2011).

According to O.A. Alekseeva (2000, 2001) and N.V. Kuryakina (2000), the correction of immunological and biochemical parameters in blood and oral fluid plays a critical role in ensuring clinical and radiological efficacy and positively influences local treatment outcomes. The authors recommended the use of the lactulose-based drug "Normase," which increases normal intestinal microflora while reducing putrefactive and pathogenic microorganisms (such as Salmonella, staphylococci, and Proteus spp.), thereby enhancing immune system function. Additionally, Normase facilitates the conversion of ammonia into non-absorbable ammonium ions in the acidic intestinal environment, which are excreted from the body, improving liver detoxification function and lowering blood glucose levels.

S.A. Ereshko (2000) developed and tested an advanced method of comprehensive periodontal treatment for diabetic patients using the phospholipid-based drug "Vitol," derived from essential plant phospholipids. This drug exhibited hypolipidemic, hypocholesterolemic, antioxidant, anti-inflammatory, wound-healing, and immunomodulatory properties.

CONCLUSION

The prevention and treatment of periodontal diseases in patients with type 2 diabetes require a comprehensive, multidisciplinary approach due to the intricate interplay between systemic metabolic dysfunction and periodontal inflammation. The reviewed studies highlight the significance of addressing both local and systemic factors in managing periodontal health in this patient group. Local therapeutic strategies, including the use of antimicrobial agents, oxygen-releasing antiseptics, and phytopreparations,

demonstrate efficacy in reducing microbial load and enhancing tissue healing. Simultaneously, systemic interventions such as hypoglycemic agents, immunomodulators, and antioxidants play a pivotal role in improving metabolic control and mitigating the progression of periodontal pathology.

Emerging therapeutic modalities, including laser therapy and hyperbaric oxygenation, show promise in improving microcirculation, reducing oxidative stress, and promoting tissue regeneration. Additionally, the integration of specialized oral hygiene protocols and patient education is crucial to maintain periodontal stability and prevent disease recurrence.

Despite advancements in therapeutic approaches, gaps remain in the development of standardized, evidence-based protocols tailored to the unique needs of diabetic patients. Future research should focus on refining treatment algorithms that incorporate both innovative technologies and traditional methods while emphasizing the importance of patient-specific management strategies. Addressing these challenges will enhance the efficacy of preventive and therapeutic measures and improve the overall quality of life for patients with type 2 diabetes.

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