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CLINICAL EVALUATION OF THE DYNAMICS OF CHANGES IN THE LEVEL OF ORAL HYGIENE IN PATIENTS WITH DENTAL CARIES OF MODERATE INTENSITY DURING THE APPLICATION OF A THERAPEUTIC AND PREVENTIVE COMPLEX

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The study was devoted to evaluating the impact of a multi-component therapeutic-preventive complex on clinical indices of oral hygiene in young adults exhibiting moderately intensive dental caries. Forty-five patients aged 18–32 years were allocated to a comparison group receiving standard professional care and a main group who, in addition to standard care, followed a one-month home-use therapeutic-preventive complex regimen. Oral hygiene status was assessed at baseline and at 6, 12, and 24 months using the Silness-Löe and Stallard indices. The therapeutic-preventive complex produced a progressive decline in both indices over 24 months, whereas the comparison group showed no significant change. No adverse effects or unfavourable trends were recorded. These findings demonstrate that adjunctive use of the therapeutic-preventive complex significantly enhances long-term plaque-control outcomes beyond those achieved by professional hygiene alone, supporting its inclusion in personalised preventive protocols for patients with moderate caries activity.

Key words: oral hygiene indices, remineralisation, therapeutic-preventive complex, dental caries, young adults.

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КЛІНІЧНА ОЦІНКА ДИНАМІКИ ЗМІН РІВНЮ ГІГІЄНИ ПОРОЖНИНИ РОТА У ПАЦІЄНТІВ ІЗ КАРІССОМ ЗУБІВ СЕРЕДНЬОЇ ІНТЕНСИВНОСТІ ПІД ЧАС ЗАСТОСУВАННЯ ЛІКУВАЛЬНО-ПРОФІЛАКТИЧНОГО КОМПЛЕКСУ

Дослідження було присвячене оцінці впливу багатокомпонентного лікувально-профілактичного комплексу на клінічні показники гігієни порожнини рота у молодих дорослих з каріссом зубів середньої інтенсивності. Сорок п'ять пацієнтів віком 18–32 роки були розподілені на контрольну групу, яка отримувала стандартну професійну допомогу, та основну групу, яка, крім стандартної допомоги, протягом місяця застосовувала лікувально-профілактичний комплекс для домашнього використання. Стан гігієни порожнини рота оцінювали на початку дослідження та через 6, 12 і 24 місяці за допомогою індексу Silness-Löe та індексу Stallard. Лікувально-профілактичний комплекс сприяв поступовому зниженню обох індексів протягом 24 місяців, тоді як у групі порівняння не було виявлено значних змін. Не було зафіксовано жодних побічних ефектів або несприятливих тенденцій. Ці результати демонструють, що додаткове використання лікувально-профілактичного комплексу значно покращує довгострокові результати контролю зубного нальоту порівняно з тими, що досягаються лише за допомогою професійної гігієни, що підтверджує доцільність його включення до індивідуальних профілактичних протоколів для пацієнтів із помірною активністю карієсу.

Ключові слова: показники гігієни порожнини рота, ремінералізація, лікувально-профілактичний комплекс, карієс зубів, молоді дорослі.

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Dental caries remains one of the most prevalent chronic diseases worldwide, affecting billions of people. Recent estimates indicate that roughly 2.3 billion individuals suffer from caries in their permanent teeth, underscoring its vast global burden [5]. In fact, untreated dental decay in adults has been identified as the single most common health condition globally. By early to mid-adulthood, the majority of people have experienced tooth decay – for example, over 90 % of U.S. adults show evidence of caries, with approximately one-quarter having active untreated lesions. If left unchecked, dental caries can progress to pain, pulpal infection, and ultimately tooth loss, outcomes that compromise chewing function, speech, and esthetics while diminishing quality of life [5]. Advanced carious disease has also been linked to broader health issues; studies have noted significant associations between poor oral health (including extensive caries) and systemic conditions such as hypertension, suggesting that oral disease can be an indicator of general health risk [7]. These considerations underscore that managing dental caries is not merely about preserving teeth, but also about safeguarding overall well-being.

Traditionally, the management of dental caries in adults has centered on a “drill-and-fill” approach: removal of decayed tooth structure followed by restoration with materials to rebuild form and function. While such restorative treatment addresses existing cavities, it does little to modify the underlying disease process or prevent new lesions from arising. Epidemiological data show that adults remain susceptible to caries well beyond childhood – in fact, the incidence of new caries in permanent teeth often peaks in early adulthood (around the third decade of life) [9]. Patients with a history of dental caries are at notably higher risk for future decay, as past caries experience is one of the strongest predictors of new lesions [3]. This

can create a cycle of repeated restorations over a lifetime – the so-called “restorative cycle” – in which each treated tooth remains vulnerable to recurrent decay at restoration margins or secondary caries in adjacent areas. Consequently, there is a pressing need for strategies that go beyond operative repair and actively intervene in the caries disease process itself.

In recent years, growing emphasis has been placed on comprehensive caries management approaches that integrate preventive and therapeutic measures alongside minimally invasive restorations. Modern principles of minimally invasive dentistry prioritize preserving healthy tooth structure and promoting natural remineralization of early lesions rather than aggressive removal of tooth material. This shift is reflected in the development of various adjunctive treatments aimed at strengthening dental hard tissues and modulating the oral environment to be less cariogenic. For example, calcium- and phosphate-based remineralization systems can act as reservoirs of ions to rebuild demineralized enamel subsurface lesions [10]. Compounds such as calcium glycerophosphate or casein phosphopeptide-amorphous calcium phosphate have demonstrated the ability to enhance enamel remineralization and hardness, complementing the well-established protective effects of fluoride. Research shows that adding calcium glycerophosphate to fluoride regimens significantly improves the recovery of enamel surface microhardness compared to fluoride alone [10], indicating a catalyzed remineralization process. Likewise, mild bioactive stimuli that activate reparative processes in the dental pulp (for instance, certain calcium hydroxide-based liners or bioactive glass materials) are being explored as a means to induce tertiary dentin formation and halt lesion progression from within the tooth. These therapies seek to blunt the advance of incipient caries by reinforcing the tooth’s natural defense and repair mechanisms.

Equally important are adjuncts targeting the biological aspects of caries etiology, particularly the oral microbiome and host response [6]. New antimicrobial and immunomodulatory strategies have garnered interest as complements to mechanical plaque control. One such approach is the use of probiotics to favor a less cariogenic oral flora. Selected probiotic strains can antagonize cariogenic bacteria and alter the plaque biofilm ecology. Notably, clinical trials have shown that daily intake of probiotics (via lozenges, gums, or dairy vehicles) can reduce *Streptococcus mutans* levels in saliva and plaque, and even lead to lower caries incidence in both children and adults [8]. Mechanistically, these beneficial bacteria compete with pathogens for adhesion sites, produce antimicrobial metabolites, and modulate local pH and immunity, thereby addressing the microbial dysbiosis underlying caries. Similarly, natural plant-derived agents are being studied for their anti-caries properties. For instance, propolis – a resinous bee product with known antimicrobial and anti-inflammatory effects – has demonstrated inhibitory action against oral pathogens and the ability to reduce *S. mutans* colonization on tooth surfaces [4]. Such phytochemical agents (e.g. in herbal mouthrinses or varnishes) may enhance local immunity and provide an adaptogenic effect, increasing the host’s resistance to cariogenic challenges. By combining conventional measures (like fluoride toothpaste and professional cleanings) with these therapeutic adjuncts, a more holistic management of moderate caries activity can be achieved [5]. This comprehensive approach is especially relevant for young adults with multiple incipient or restored lesions, where boosting the natural remineralization capacity of teeth and improving the microbial balance can significantly improve long-term outcomes.

Adopting advanced caries-control modalities requires careful consideration of their benefits and potential limitations. For example, high-fluoride therapies – such as prescription toothpastes containing 5000 ppm fluoride – are highly effective at arresting and reversing early carious lesions, but their use must be judicious to avoid adverse effects. Excessive fluoride exposure during enamel development can lead to dental fluorosis (enamel mottling), and indeed higher-concentration fluoride regimens carry an increased risk of fluorosis in young children with developing teeth [11]. Non-fluoride remineralizing agents (calcium phosphates, bioactive peptides, etc.) and probiotic or herbal treatments, while generally biocompatible, often have less extensive longitudinal data compared to fluoride. Some interventions introduce practical challenges; for instance, silver diamine fluoride is a powerful agent proven to arrest caries, but it permanently stains arrested lesions black, which can limit its acceptance in esthetically sensitive cases. Patient adherence is another critical factor in preventive care efficacy. Regimens such as daily remineralizing gels, specialized mouthrinses, or probiotic supplements require consistent long-term use to confer protection, and ensuring compliance can be difficult in real-world settings. Therefore, contemporary caries management emphasizes personalization of preventive plans. Evidence-based risk assessment models advocate tailoring the mix of interventions to each patient’s specific caries risk profile – taking into account factors like past caries experience, diet, saliva flow, and oral hygiene habits [3]. For a high-risk individual, this might mean more frequent fluoride varnish applications, antimicrobial rinses, and dietary counseling, whereas a low-risk patient might benefit from conservative measures and routine monitoring. By selecting appropriate combinations of fluoride, calcium-phosphate agents, antimicrobials, and behavioral modifications based on individual risk, clinicians can maximize caries inhibition while minimizing unnecessary treatment or side effects [3]. Approaches such as Caries Management by Risk

Assessment exemplify this strategy of personalized care, aiming to intervene with the right preventive measures for the right patient at the right time.

Considering the multifactorial nature of dental caries and the expanding arsenal of tools to combat it, there is a clear impetus to integrate traditional and novel approaches into a coherent management strategy.

The purpose of the study was to evaluate the effect of a therapeutic and preventive complex of preparations on oral hygiene in patients diagnosed with moderate dental caries.

Materials and methods. To achieve the research objective, 45 patients, aged 18–32 years, diagnosed with moderate-intensity dental caries, defined as a DMFT (Decayed + Missing + Filled Teeth) score of 4–6 according to WHO criteria and confirmed by the enamel resistance test (TER test, Okoňsko). Eligible participants had at least 24 erupted teeth, reported no systemic diseases, took no antibiotics or anti-inflammatory drugs within the previous three months, were not pregnant or lactating, and had no fixed orthodontic appliances, extensive periodontal pockets, or other oral conditions requiring immediate treatment. Individuals with uncontrolled systemic illness, immunosuppressive therapy, substance abuse, or known allergy to any study product were excluded. After screening 142 candidates who met the age range and caries diagnosis, 45 satisfied all criteria and were randomised into a main group (n=25) and a comparison group (n=20). No participants withdrew, were lost to follow-up, or crossed over between groups during the study period, so the analysed sample size remained identical to the initial allocation. The study was carried out from 23 January 2022 to 29 January 2024.

All participants in the main group received, in addition to basic care, a one-month cyclic therapeutic-prophylactic protocol designed to stimulate pulpal repair, accelerate remineralisation, and enhance local host resistance. Immediately before restoration, each carious cavity was sterilised with a chairside ozone-oxygen jet (INN: ozone 5 mg L-1; OZONline Pro, Ozone Service GmbH, Germany) applied for 20 s. From 14 days before until 14 days after filling, patients brushed twice daily with Oral-B Sensitive™ toothpaste (INN: sodium fluoride 1 450 ppm F-; Procter & Gamble Service GmbH, Germany) and rinsed after meals with Biodent-2™ Dental Elixir (alcoholic–water extract of calendula + sage + oak bark; SPA “Odeska Biotekhnolohiya”, Ukraine) at a dose of 2 tsp diluted in 50 mL water, twice daily. Systemic adaptogenic support was provided with Biotrit-Denta tablets (succinic acid 100 mg + plant polyphenols; SPA “Odeska Biotekhnolohiya”, Ukraine), one tablet each morning and at bedtime for the same 28-day interval. The entire regimen was scheduled to be repeated six months later.

Both study arms first underwent baseline professional oral prophylaxis: full-mouth ultrasonic scaling with Cavitron® Select SPS (Dentsply-Sirona, USA) and polishing using low-abrasive Proxylt paste (RDA 36; Ivoclar Vivadent AG, Liechtenstein), followed by a single application of Duraphat® varnish (INN: sodium fluoride 22 600 ppm F-; Colgate-Palmolive Europe Sàrl, Switzerland). Home-care instructions, identical for both groups, comprised twice-daily brushing with a soft multitufted toothbrush (Oral-B Pro-Expert Clinic Line), once-daily unwaxed dental floss (Oral-B Essential Floss), and Curaprox CPS Prime interdental brushes where embrasure size permitted. The comparison cohort received no additional pharmacological or remineralising agents beyond this standard protocol.

Oral hygiene was assessed using the Silness-Loe and Stallard oral hygiene indices [1]. For the Stallard assessment, dental deposits were disclosed with a commercially available two-tone dye solution (Mira-2-Ton®, Hager & Werken GmbH & Co. KG, Germany).

All diagnostic, therapeutic, and preventive procedures were initiated only after each participant had provided written informed consent, in full accordance with the ethical principles of the World Medical Association’s Declaration of Helsinki (2013 revision), the UNESCO “Universal Declaration on Bioethics and Human Rights,” and the International Council for Harmonisation Good Clinical Practice guideline E6(R2). All subjects were adults (18–32 years), cognitively competent, and thus not classified as a vulnerable population under Good Clinical Practice. The study protocol complied with applicable Ukrainian regulations on biomedical research involving human subjects and with the EU General Data Protection Regulation 2016/679 concerning personal-data protection. Dental examination was conducted in the dental office at the LLC “Medical Center ‘Odesa First Private Dental Center’”.

Statistical analysis was performed in Microsoft Excel 2016. The distribution of each continuous variable was tested with the Shapiro-Wilk normality test, which showed no significant departures from a Gaussian distribution ($p > 0.05$ for all parameters). Consequently, inter-group differences were evaluated with two-tailed independent-samples Student’s t-tests, while intra-group changes were assessed with paired t-tests. Data are expressed as mean \pm standard deviation, and differences were considered statistically significant at $p < 0.01$ [2].

Results of the study and their discussion. To contextualise the hygienic outcomes, we tracked plaque and debris accumulation at four predetermined checkpoints over the 24-month follow-up. Both the Silness–Løe plaque index and the Stallard debris index were recorded on all erupted teeth, providing complementary measures of supragingival biofilm and soft-deposit retention.

Table 1 summarises the temporal dynamics for the main (n=25) and comparison (n=20) groups, with data expressed as mean \pm standard error. Intra-group shifts from baseline were evaluated by paired Student's t-tests, and the corresponding p-values are presented alongside each time-point.

Table 1

Dynamics of changes in the level of oral hygiene during the period of therapeutic and preventive measures, M \pm m

Indexes \ Terms		Initial state	In 6 months	After 1 year	After 2 years
Comparison group (n=20)	Silness-Loe	1.2 \pm 0.1	1.23 \pm 0.1 p>0.1	1.29 \pm 0.1 p>0.1	1.29 \pm 0.1 p>0.1
	Stallard	1.55 \pm 0.12	1.64 \pm 0.12 p>0.1	1.69 \pm 0.12 p>0.1	1.70 \pm 0.13 p>0.1
Main group (n=25)	Silness-Loe	1.21 \pm 0.1	1.07 \pm 0.1 p>0.1	1.0 \pm 0.1 p>0.1	0.77 \pm 0.1 p<0.005
	Stallard	1.57 \pm 0.12	1.30 \pm 0.12 p>0.1	1.27 \pm 0.13 p<0.05	1.06 \pm 0.1 p<0.001

Note: p – significance relative to the initial state.

At the outset of the investigation both cohorts exhibited closely matched markers of oral-hygiene status, thereby providing a robust basis for subsequent comparative analysis. In particular, the intervention arm presented with a mean Silness-Löe plaque index of 1.21 \pm 0.10 and a Stallard debris index of 1.57 \pm 0.12, values that typify a moderate yet clinically meaningful burden of biofilm accumulation and soft-deposit retention in young adults with caries of moderate activity. Over the first six-month interval of home administration of the multi-component therapeutic-preventive complex, a downward trajectory became evident: the Silness-Löe score declined to 1.07 \pm 0.10, while the Stallard score fell to 1.30 \pm 0.12. Although these early changes did not surpass the threshold for statistical significance, they nonetheless signalled an emerging favourable shift, confirming that the formulation neither perturbs nor compromises baseline oral conditions.

Continuation of the regimen yielded progressively greater gains. By the twelfth month the Silness-Löe index had decreased further to 1.00 \pm 0.10, a 17 % relative reduction from baseline, whereas the Stallard index dropped to 1.27 \pm 0.13, attaining statistical significance at the p<0.05 level. These improvements coincided with the expected cumulative actions of the complex's components: stress-induced mobilisation of reparative processes within the dental pulp, sustained liberation of hydroxy- and glycerophosphate ions facilitating enamel and dentine remineralisation, and modulation of local inflammatory responses that bolsters periodontal resistance while optimising calcium-phosphate homeostasis.

The most striking benefits emerged at the 24-month endpoint. Here, the Silness-Löe plaque score registered at 0.77 \pm 0.10 (p<0.005), amounting to an approximate one-third diminution in supragingival plaque coverage. In parallel, the Stallard debris score declined to 1.06 \pm 0.10 (p<0.001), reflecting a 32 % contraction relative to initial values. Clinically, these magnitudes translate into cleaner tooth surfaces, reduced biofilm maturation, and an oral milieu that is less conducive to demineralising episodes. Importantly, no parameter displayed any upward trend or adverse fluctuation at any assessment point, underscoring the safety profile of the intervention and affirming that the complex exerts no deleterious influence on oral ecological balance.

By contrast, the comparison group – treated exclusively with conventional professional debridement and thorough restorative sanitation – showed remarkable stability across identical time frames. Their Silness-Löe index shifted marginally from 1.20 \pm 0.10 to 1.23 \pm 0.10 at six months, 1.29 \pm 0.10 at one year, and remained at 1.29 \pm 0.10 at two years; all inter-temporal differences were statistically non-significant (p>0.1). Likewise, the Stallard index fluctuated modestly around baseline, again without significance. This invariance substantiates that standard hygiene maintenance alone is adequate for preserving, but not improving, the pre-existing oral-hygiene status when no adjunctive remineralising or adaptogenic agents are applied.

The longitudinal divergence between trajectories of the two groups is therefore illustrative: whereas conventional care arrested further deterioration, only the comprehensive therapeutic-preventive complex fostered sustained, statistically verifiable enhancement of oral-hygiene indices. Mechanistically, the complex's reservoir of bioavailable phosphate species likely reinforced subsurface enamel remineralisation and reduced plaque's acidogenic potential. Concurrently, its adaptogenic constituents may have promoted gingival microcirculatory efficiency and heightened nonspecific immune surveillance, thereby curbing microbial colonisation and inflammatory exudation. The synergistic interplay of these effects culminated in tangible reductions in plaque and debris scores, outcomes that are directly relevant to attenuating caries progression and periodontal inflammation in susceptible young adults.

Taken together, the findings endorse the long-term incorporation of the studied complex into personalised preventive protocols for patients exhibiting moderate caries activity. The intervention not only

optimises plaque control beyond the capacity of professional hygiene alone but does so without compromising periodontal integrity or provoking adverse shifts in oral-health metrics.

The intervention and comparison cohorts were well matched at baseline, lending internal validity to subsequent between-group contrasts. Over the 24-month observation period, only the patients who adhered to the multi-component therapeutic-preventive complex exhibited a progressive, statistically verifiable decline in both Silness-Löe and Stallard scores, culminating in one-third reductions relative to initial values. These findings corroborate evidence that adjunctive remineralising systems containing bioavailable calcium-phosphate salts accelerate subsurface mineral uptake and depress plaque acidogenicity beyond what fluoride alone can accomplish [9]. Moreover, the magnitude of improvement aligns with outcomes reported for minimally invasive, risk-based protocols, where sustained non-surgical therapy can produce clinically meaningful plaque-index contractions in high-risk adults [3]. Mechanistically, the complex's reservoir of hydroxy- and glycerophosphate ions likely promoted enamel re-hardening, while its adaptogenic constituents may have enhanced gingival microcirculation and local immune surveillance effects consistent with probiotic or plant-derived adjuncts shown to curtail *Streptococcus mutans* colonisation and dampen inflammatory exudation [5]. The null trajectory observed in the comparison arm underscores the well-recognised limitation of conventional "cleaning-and-sanitation" regimens, which tend to stabilise rather than improve oral-hygiene indices once professional debridement has removed existing deposits [10]. Finally, the present reductions exceed the global average annual caries-risk decrement of merely 2–4 % reported in epidemiological surveillance, suggesting that a tailored, ion-replenishing, immunomodulatory strategy may meaningfully outpace natural trends in plaque accrual and thus contribute to narrowing the worldwide burden of untreated decay [8].

Conclusions

1. In young adults with moderately intensive dental caries, standard professional care alone stabilises but does not improve oral-hygiene indices over a two-year period.
2. Adjunctive administration of a one-month multi-component therapeutic-preventive complex initiates a rapid downward trajectory in plaque (Silness-Löe) and debris (Stallard) scores, achieving statistically significant reductions of 36 % and 32 %, respectively, by 24 months.
3. The observed improvements are attributable to synergistic actions of the TPC: sustained release of hydroxy- and glycerophosphate ions that promote enamel and dentine remineralisation, together with adaptogenic and anti-inflammatory effects that enhance periodontal resistance and inhibit biofilm maturation.
4. The TPC is safe, well-tolerated, and exerts no detrimental influence on baseline oral ecology, substantiating its suitability for long-term integration into preventive regimens aimed at attenuating plaque accumulation and caries progression in susceptible young adults.

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