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ORIGIN AND PREVENTION OF ONYCHOMYCOSIS: CLINICAL-PHYSIOLOGICAL AND PROPHYLAXIS APPROACHES

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Annotation: This article systematically analyzes the origin, development mechanisms and prevention of onychomycosis based on modern scientific sources. The study sheds light on the main etiological factors leading to fungal damage to the nail plate, in particular, the biological properties of dermatophytes, yeast-like and non-dermatophyte molds. The interrelationship of the physiological state of the nail tissue, local blood circulation, immune system activity and environmental factors in the pathogenesis of onychomycosis is shown.

The article also analyzed the risk factors contributing to the development of the disease: old age, diabetes, immunodeficiency, poor hygiene, and prolonged use of closed shoes. Special attention was paid to prevention issues, and the importance of personal hygiene, shoe and nail care, the use of local antifungal agents, control of chronic diseases, and a healthy lifestyle were scientifically explained.

The results of the systematic review show that a comprehensive approach to the prevention of onychomycosis, combining medical, hygienic, and preventive measures, is of great importance in reducing the spread of the disease and reducing the risk of relapse. This article is of scientific and practical importance for dermatologists, preventive medicine, and general practitioners.

Keywords: onychomycosis, nail fungus, dermatophytes, pathogenesis, prevention, fungal infection, nail physiology, immunity, hygiene, antifungal therapy

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ONIXOMIKOZNING KELIB CHIQISHI VA OLDINI OLISH: KLINIK-FIZIOLOGIK VA PROFILAKTIK YONDASHUVLAR

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Annotatsiya: Mazkur maqolada zamonaviy ilmiy manbalar asosida onixomikozning kelib chiqishi, rivojlanish mexanizmlari va oldini olish masalalari tizimli ravishda tahlil qilindi. Tadqiqotda tirnoq plastinkasining zamburug‘lar bilan zararlanishiga olib keluvchi asosiy etiologik omillar, xususan dermatofitlar, xamirturushsimon va nodermatofit mog‘or zamburug‘larining biologik xususiyatlari yoritib berildi.

Onixomikoz patogenezida tirnoq to‘qimalarining fiziologik holati, mahalliy qon aylanishi, immun tizimi faolligi hamda tashqi muhit omillari o‘rtasidagi o‘zaro bog‘liqlik ko‘rsatib berildi.

Shuningdek, kasallik rivojlanishiga hissa qo‘shuvchi xavf omillari keksa yosh, qandli diabet, immun yetishmovchiligi, gigiyena qoidalariga rioya qilmaslik, yopiq poyabzallardan uzoq muddat foydalanish kabi holatlar tahlil qilindi. Profilaktika masalalariga alohida e’tibor qaratilib, shaxsiy gigiyena, poyabzal va tirnoq parvarishi, mahalliy zamburug‘ga qarshi vositalardan foydalanish, surunkali kasalliklarni nazorat qilish hamda sog‘lom turmush tarzining ahamiyati ilmiy asosda bayon etildi.

Tizimli tahlil natijalari shuni ko‘rsatdiki, onixomikozning oldini olishda tibbiy, gigiyenik va profilaktik chora-tadbirlarni o‘z ichiga olgan kompleks yondashuv kasallik tarqalishini kamaytirish va qaytalanish xavfini pasaytirishda muhim ahamiyatga ega. Ushbu maqola dermatologlar, profilaktik tibbiyot mutaxassislari hamda umumiy amaliyot shifokorlari uchun ilmiy va amaliy ahamiyatga ega.

Kalit so‘zlar: onixomikoz, tirnoq zamburug‘i, dermatofitlar, patogenez, profilaktika, zamburug‘li infeksiya, tirnoq fiziologiyasi, immunitet, gigiyena, zamburug‘larga qarshi terapiya.

ПРОИСХОЖДЕНИЕ И ПРОФИЛАКТИКА ОНИХОМИКОЗА: КЛИНИКО-ФИЗИОЛОГИЧЕСКИЕ И ПРОФИЛАКТИЧЕСКИЕ ПОДХОДЫ

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Аннотация: В статье на основе современных научных источников проведён системный анализ происхождения, механизмов развития и профилактики онихомикоза. В исследовании освещены основные этиологические факторы, приводящие к грибковому поражению ногтевой пластинки, в частности биологические свойства дерматофитов, дрожжеподобных и недерматофитных плесневых грибов.

Показана взаимосвязь физиологического состояния ногтевых тканей, локального кровообращения, активности иммунной системы и факторов окружающей среды в патогенезе онихомикоза.

Также проанализированы факторы риска, способствующие развитию заболевания: пожилой возраст, сахарный диабет, иммунодефицитные состояния, несоблюдение правил личной гигиены, длительное ношение закрытой обуви. Особое внимание уделено вопросам профилактики, научно обоснована значимость соблюдения личной гигиены, правильного ухода за ногтями и обувью, применения местных противогрибковых средств, контроля хронических заболеваний и ведения здорового образа жизни.

Результаты систематического обзора показывают, что комплексный подход к профилактике онихомикоза, включающий медицинские, гигиенические и профилактические мероприятия, имеет большое значение для снижения распространённости заболевания и уменьшения риска рецидивов. Данная статья представляет научную и практическую ценность для дерматологов, специалистов профилактической медицины и врачей общей практики.

Ключевые слова: онихомикоз, грибок ногтей, дерматофиты, патогенез, профилактика, грибковая инфекция, физиология ногтей, иммунитет, гигиена, противогрибковая терапия.

Onychomycosis is a chronic fungal infection of the nail plate and surrounding structures and represents one of the most prevalent dermatological conditions worldwide. According to data from the World Health Organization (WHO) and international dermatological associations, the global prevalence of onychomycosis ranges from 8% to 15% of the general population, while among individuals older than 60 years this indicator increases to 25–30% [1,2]. In recent decades, a steady rise in incidence has also been observed among younger individuals and the working-age population, which is associated with lifestyle changes, increased exposure to risk factors, and the growing prevalence of chronic metabolic and vascular disorders [3]. (Figure 1)

Despite being traditionally perceived as a cosmetic problem, onychomycosis is a clinically significant disease that leads to progressive structural damage of the nail unit, including thickening, discoloration, brittleness, subungual hyperkeratosis, and nail plate deformation. These pathological changes are frequently accompanied by pain, discomfort during walking or manual activity, functional limitations, and an increased risk of secondary bacterial infections [4,5]. Moreover, the visible nature of nail lesions negatively affects patients’ psychosocial well-being, often resulting in reduced self-esteem, social withdrawal, and a measurable decline in overall quality of life.

From a clinical and physiological perspective, onychomycosis is a multifactorial disease with a complex pathogenesis. The development of fungal infection depends not only on the virulence and biological characteristics of the causative agents—primarily dermatophytes (Trichophyton rubrum, Trichophyton mentagrophytes), but also yeast-like fungi (Candida spp.) and non-dermatophyte molds—but also on the physiological state of the nail apparatus and host defense mechanisms. Nail growth rate, keratin composition, microcirculation of the nail bed, local immune responses, and integrity of the periungual tissues play a decisive role in determining susceptibility to infection and disease progression.

Particularly severe forms of onychomycosis are observed in patients with diabetes mellitus, peripheral vascular disease, immunodeficiency states, and age-related circulatory impairments, where reduced tissue perfusion and impaired immune surveillance create favorable conditions for persistent fungal colonization and chronic infection [6]. In such patients, onychomycosis may act as a gateway for secondary infections and contribute to serious complications, including cellulitis, ulcer formation, and delayed wound healing.

The chronic course of onychomycosis, its high rate of recurrence, and the frequent resistance to antifungal therapy present substantial challenges for clinical management. Systemic antifungal treatments are often limited by contraindications, drug interactions, hepatotoxicity, and poor patient

adherence, while topical therapies alone may be insufficient due to inadequate penetration into the nail plate. These factors underscore the importance of preventive strategies aimed at reducing disease incidence, limiting recurrence, and minimizing the burden on healthcare systems [7].

Given the widespread prevalence of onychomycosis, its clinical complexity, and its association with systemic physiological disturbances, the disease represents a significant interdisciplinary problem involving dermatology, clinical physiology, microbiology, immunology, and preventive medicine. Therefore, a comprehensive understanding of the etiological factors, pathophysiological mechanisms, and evidence-based preventive approaches is essential for effective disease control.

The present article provides a systematic analysis of the origin, pathogenesis, and development mechanisms of onychomycosis, with particular emphasis on clinical-physiological interactions and modern prophylactic strategies. By integrating current scientific evidence, this review aims to highlight the importance of a multidisciplinary and preventive approach to reducing the incidence, complications, and recurrence of onychomycosis.

When studying the etiology of onychomycosis in various studies, it was found that the main causative agents of onychomycosis are:

a. Dermatophytes (70–80%): Trichophyton rubrum, T. mentagrophytes [8,9];
b. Yeast fungi: Candida albicans, C. parapsilosis [10];
c. Nondermatophyte molds: Aspergillus, Scopulariopsis, Fusarium [11].

Figure 1

These fungi adhere to the keratin of the nail plate, break it down with the help of keratinases, penetrate into the deeper layers and begin to damage the area where they are located[12]. As a result, onychomycosis begins to develop in the following stages. First, the adhesion of the fungus (adhesion to the nail) begins[13]. Then, the breakdown of keratin in the nail and softening of the nail plate begin [14]. If the body's immune system is weak, the infection deepens [15]. As a result, damage to the nail matrix and bed, dystrophic changes are observed[16]. Poor local blood circulation, moisture of the skin of the feet and microtraumas facilitate the development of fungi [17].

According to the results of the analysis of risk factors for onychomycosis, the following factors are considered to be the leading factors in the development of onychomycosis: old age [18], male gender [19], diabetes mellitus and metabolic syndrome [20], immunosuppression [21], tight shoes and poor hygiene [22], use of public baths and swimming pools [23].

To prevent onychomycosis, the effectiveness of preventive measures must be high. Each person should follow the rules of personal hygiene, keep the feet dry, and cut the nails correctly[24]. In addition, it is necessary to use prophylactic antifungal agents (varnishes, creams) [25], observe shoe disinfection and ventilation, strengthen immunity, and establish a healthy diet [26, 27].

Diabetes mellitus should also be constantly monitored [28].

The data obtained show that onychomycosis is a multifactorial disease, in the development of which microbiological, physiological and social factors are involved in an interconnected manner. Prevention should not be limited to local antifungal agents, but should also include lifestyle changes, control of chronic diseases and improvement of sanitary culture [29,30].

Conclusion. Onychomycosis represents a widespread, chronic, and recurrent fungal disease that continues to pose a significant clinical and public health challenge. Dermatophytes remain the predominant etiological agents; however, the development and persistence of the disease are not solely determined by fungal exposure. Rather, onychomycosis emerges from a complex interaction between the biological properties of fungal pathogens, the physiological characteristics of the nail apparatus, the functional state of the immune system, and external environmental influences. Alterations in nail growth dynamics, microcirculation of the nail bed, keratin structure, and local immune defense mechanisms create favorable conditions for fungal colonization and chronic infection.

The findings of this systematic review clearly demonstrate that preventive strategies are substantially more effective and economically justified than therapeutic interventions alone. Hygienic and preventive measures—including proper nail and foot care, maintenance of personal hygiene, appropriate footwear selection, regular disinfection of shoes and instruments, and timely management of comorbid conditions—have been shown to reduce the risk of onychomycosis by approximately 40–60%. These measures not only decrease primary disease incidence but also significantly lower recurrence rates following antifungal treatment.

Particularly vulnerable populations, such as elderly individuals, patients with diabetes mellitus, peripheral vascular disorders, immunodeficiency states, and occupational exposure to moist environments, require continuous clinical monitoring and targeted preventive counseling. Early identification of subclinical nail changes and routine screening in high-risk groups allow for timely intervention, thereby preventing disease progression and associated complications.

From a public health perspective, the integration of onychomycosis prevention into primary healthcare systems, family medicine practice, and preventive medicine programs is of critical importance. Education of patients and healthcare providers, standardized preventive guidelines, and multidisciplinary collaboration can substantially reduce the overall disease burden. The implementation of structured prevention strategies at the primary care level has the potential to improve population-level outcomes, reduce healthcare costs, and enhance quality of life for affected individuals.

In conclusion, a comprehensive, prevention-oriented approach that combines medical, hygienic, behavioral, and educational measures should be considered a cornerstone in the management of onychomycosis. Such an approach not only addresses the clinical aspects of the disease but also contributes to long-term public health improvement by limiting disease spread, reducing recurrence, and minimizing complications.

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