

Review of the Clinical Types of Dermatophytes

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ABSTRACT

Fungi known as dermatophytes require keratin in order to develop. "Ringworm" is the common term for superficial fungus infections that affect the skin's keratinized layers and its limbs in both humans and animals. These fungi have the potential to superficially infect nails, hair, and skin. Ringworm fungi have the ability to penetrate all layers of skin. Dermatophytes can be transmitted directly by people (anthropophilic organisms), indirectly by fomites, and by animals (zoophilic organisms), soil (geophilic organisms), and other people. Dermatophytes are the cause of the medical condition known as dermatophytosis. Approximately 25% of the global population suffers from dermatophytosis, and no human population is immune to these mycotic disorders. There are three genera in total. the more than twenty species of dermatophytes: *Trichophyton*, *Microsporum*, and *Epidermophyton*. By providing reliable epidemiological data, it is imperative that we expand broaden public knowledge of the importance of these illnesses and deepen our understanding of fungal biology and pathology. Ecological classifications, clinical potential for pathogenicity manifestations, and "chemical and natural" dermatophytosis therapy alternatives are some of the review themes.

Keywords- Dermatophytosis, Tinea, Therapy, Keratinophilic, Keratinolytic.

I. INTRODUCTION

Since the discovery of fungi by the ancient Greeks, the perception of these microorganisms' harmfulness has evolved and persists to this day. As of right present, it is understood that individuals with robust immune systems are typically not problematic [1]Worldwide, Fungal dermatophytes are a frequent cause of illnesses affecting the nails, skin, and hair. *Trichophyton rubrum* and *Trichophyton interdigitale* are the most prevalent agents [2,3]. However, the genera *Microsporum*, *Trichophyton*, and *Epidermophyton* contain other dermatophytes. Differential adaptation to specific These genera and their species can be further classified as anthropophilic, zoophilic, and geophilic animals according to hosts and ecological habitats. Some

species that are anthropophilic include *Trichophyton rubrum* and *Epidermophyton floccosum*., tend to adapt to humans and cause chronic infections with mild clinical symptoms, whereas zoophilic dermatophytes from animals, such as *Trichophyton canis*, *Trichophyton benhamiae*, and *Trichophyton mentagrophytes*, or geophilic species from soil, such as *Microsporum gypseum*, are less adapted to human epidermis. [4]. Their capacity to attack human and other animal cornified tissue causes scaly skin, damaged hairs, and disintegrating nails. The fungal infection is limited to the cornified layers due to its inability to infiltrate immune-competent hosts' mucosal surfaces, deeper tissues, or organs. The keratinophilic and keratinolytic activities of dermatophytes are two of their main traits. Moreover, some of them may penetrate tissues in vivo and result in

tineas [5,6]. As a result, dermatophytosis is distributed globally with notable regional variations. With a prevalence of 40% in the 20–60 age range. It is more prevalent in older people and grownups. The illness burden in young children is only 5%. (under 10 years old) [7,8]. Fungal skin diseases are considered one of the most serious health problems that some people around the world suffer from, as between 20% and 50% of the world's population suffer from them, particularly in developing nations, because to the density of population, poor health conditions, and malnutrition[9].

II. TAXANOMY OF DERMATOPHYTES

Dermatophytes have frequently been assigned to the "Imperfect Fungi" or Deuteromycetes class. The sexual stage of dermatophytes is useful for species identification and epidemiological studies. Based on differences in conidial morphology, dermatophyte Three genera can be used to group species: "*Microsporium*, *Epidermophyton*, and *Trichophyton*". [10]

2-1-*Epidermophyton*

Large macroconidia in the genus are club-shaped, multicellular, thin-walled, and grouped in bunches. There are no microconidia produced. The genus's characteristics come from *E. floccosum*. Based on anamorph morphology, there are two species of *Epidermophyton*: *E. floccosum* and *E. stockdaleae*. The majority of tinea cruris infections are caused by *E. floccosum*, the only pathogenic "anthropophilic" species under this genus that are known to be widely distributed. [11].

2-2-*Microsporium*

This genus contains both macroconidia and microconidia. Macroconidia have a echinulate cell wall thickness, are spindle-shaped, and are multiseptate. They may also be common or uncommon. But the main feature that distinguishes this genus is the echinulations on the macroconidial cell wall. Pyriform microconidia have a diameter of about 2-3 μm . *M. audouinii* is the type species. Anamorph morphology suggests that there are about eighteen species of *Microsporium*. *M. canis* is the most common reason in the Mediterranean region of tinea corporis and tinea capitis. [12].

2-3-*Trichophyton*

Both macroconidia and microconidia in this genus have smooth walls. Macroconidia have cigar-shaped walls. Microconidia can have an uneven shape or be pyriform, measuring 2-3 μm . Some species don't often make macroconidia. *Trichophyton* comprises 25 species, with *T. tonsurans* serving as the type species. [12,13].

III. ECOLOGICAL GROUPINGS AND SOURCES OF INFECTION

Three ecological groupings are distinguished from dermatophytes based on their host preferences and

natural habitats: those that are soil-dwelling, zoophilic (living on animals), and anthropophilic (living on humans). [14,15].

3-1- *Anthropophilic Dermatophytes*

Anthropophilic dermatophytes, which are thought to have developed from geophilic dermatophytes, are the type of dermatophytes that preferentially infect humans. [16,17]. This group includes about ten dermatophyte species, with *Trichophyton* and *Epidermophyton* being the two major genera. [15]. *Trichophyton rubrum*, *Trichophyton interdigitale*, and *Epidermophyton floccosum* are the main culprits behind most infections; *T. rubrum* is the most commonly distributed. People get infected by dermatophytes. [18]. These organisms have adapted effectively to the immunological and physiological systems of humans, which has led to modest clinical symptoms and a weakened immune response. [19]. Periodic infections that are non-inflammatory and have more notable clinical characteristics can occasionally endure for months or even years. Each species appears to only use a single kind of mating, indicating that asexual reproduction is their only means of reproduction. [15,20,21]. There is a theory that these species no longer experience as much selective pressure due to their adaptation to humans, which leads to the extinction of one mating species. [22]. While *M. canis* infections can result from animal interaction, *T. rubrum* and *T. tonsurans* are typically responsible for human-to-human transmission diseases. [23]. Although anthropophiles account for the bulk of human cases of dermatophytosis, zoophiles can also infect humans and produce zoonotic dermatophyte diseases. [24].

3-2-*Zoophilic Dermatophytes*

It has evolved for species of dermatophytes that are zoophilic and live on non-human animals. [25]. Animal illnesses are mostly caused by the following species: *Microsporium canis*, *Nannizzia persicolor*, *Nannizzia nana*, *Trichophyton equinum*, *Trichophyton mentagrophytes*, and *Trichophyton verrucosum* [25]. Infections in humans are primarily brought on by *M. canis*, *T. mentagrophytes*, and *T. verrucosum* [26]. Compared to infections caused by anthropophilic dermatophytosis, these infections typically cause noticeably higher inflammation and a shorter infection period in humans. [15]. Unlike human illnesses, Animal ringworm, or dermatophytosis, is usually not further characterized based on the site of the infection. Clinical symptoms usually consist of erythematous-bordered circular alopecic lesions, and pruritus is not frequently seen. [27]. Animals may carry dermatophytes asymptotically, which can lead to occult transmission to people or other animals with whom they come into close contact. [27]. The main hosts of *M. canis* are cats. Farmers and livestock workers are more vulnerable to contracting zoonotic infections as a result of other zoophiles infecting ruminants and other livestock. [28,29]. The dermatophyte species on ruminants that are

most commonly isolated is *Trichophyton verrucosum* [30]. Farms that raise beef cattle using rigorous breeding their animals in higher-density populations, there is a correlation between an increase in the occurrence of dermatophytosis in cattle and these farms. [27,30]. *N. nana* can infect both dogs and goats. [27]. The main dermatophyte that infects horses and infrequently causes human dermatophytosis is *Trichophyton equinum*. [31]. Because zoophiles can multiply in soil, it might be difficult to distinguish them from geophiles. [32].

3-3-Geophilic Dermatophytes

Most commonly found in soil and animal excrement, Geophilic dermatophytes are able to occasionally infect both humans and animals. [15,25]. Because they break down keratin and replenish the nutrients in the plant, these fungus are crucial to the ecology. [33]. Geophile infections are often environmental in origin and do not spread across hosts. [33,34]. A geophile would be categorized as a zoophile if it could sustain a colony on certain hosts and spread infection more frequently. [32]. The most frequent species that infect both people and animals is *Nannizzia gypsea* (former name *Microsporum gypseum*) [25,28]. Frequent exposure to dirt outdoors, especially in the absence of protection, increases the chance of developing geophilic dermatophytosis. [27]. Farmers are among the professions that are more susceptible to contracting this virus. [33].

The clinical manifestation of dermatophytosis produced by geophiles is different from that of anthropophilic and zoophilic dermatophytosis, notwithstanding the rarity of infections. In these situations, the inflammatory response is typically more pronounced and the infection period is typically shorter, confirming that host-fungus adaptation eventually leads to a weakened immune response and an extended time frame for replication. [19]. Unlike anthropophiles, geophiles have not been subject to host-specific selection forces since they have not evolved to a host species. [35].

People can get tinea corporis and rarely tinea capitis from *N. gypsea*. [36]. Compared to host-adapted species, geophilic animals have preserved two types of mating and are more likely to reproduce sexually. [20,21]. It is hypothesized that fruiting bodies, which develop during sexual reproduction, are most suited for the moist soil environment. No direct isolation of such structures from an infected animal has been done. [32]. Although dermatophyte species belonging to different categories differ in terms of habitat and other characteristics like reproduction, all dermatophytes can be diagnosed using the same clinical techniques [36].

IV. PATHOGENESIS OF DERMATOPHYTES

The production of diverse proteins or enzymes by dermatophytes is crucial for their invasion of

keratinous skin layers. [37] Important enzymes such as DNAses, phosphatases, adhesins, lipases, phosphatases, keratinases, and non-specific proteases help dermatophytes carry out various pathogenic functions like attaching to and penetrating the skin's stratum corneum, evading the host immune system, and scavenging nutrients. [37] 96% of the 234 clinical dermatophytes isolates were found to produce phospholipase and keratinase, whereas 14% and 23% of isolates produced gelatinase and elastase, respectively. [38]. When live fungal arthrospores or hyphae come into touch with a person's skin, the condition known as dermatophytosis is frequently triggered. This is because the right conditions are then present to promote the adhesion and germination of the fungi that lead to infection. [39]. Dermatophytosis often develops on human skin after an incubation period of one to two weeks. [40]. The best conditions for the growth of infections are warmth and humidity. [41]. However, a number of factors, including overcrowding, wearing occlusive clothing, increasing urbanization, low socioeconomic level, animal interaction, and inadequate cleanliness, can raise the risk of contracting dermatophytosis. [42].

V. CLINICAL FEATURES OF DERMATOPHYTOSIS

The clinical manifestation of dermatophytosis, also known as tinea, varies based affecting the immunological system of the host, the type of dermatophytes, and the infection site. [39] The general features of tinea in humans are indicated by the emergence of an annular patch with a center clearing and an advancing, elevated, scaling boundary. [40,43]. These characteristics could exhibit varying degrees of inflammation and scaling, which could result in scarring and baldness. [44]. Thus, in a severe form of dermatophytosis infection, inflammation and erythematous symptoms are easily recognized. [41]. Other clinical characteristics range from mild to advanced degrees, including scaling, vesicles or plaster formation, itching, maceration, pain, and erythematous rate. [41,45]. The primary cause of these clinical symptoms is the diffusible of fungal compounds through the skin's Malpighian layer, which triggers a host response. [39].

5-1- Tinea Corporis (glabrous skin)

On the trunk, extremities, or face, tinea corporis, additionally referred to as ringworm, usually manifests as one or more annular, scaly lesions with core clearing, a slightly raised, reddened edge, and sharp margination (an abrupt transition from abnormal to normal skin). There may be pustules or follicular papules around the lesion's edge. Itching varies. [46]. Depending on where the infection first appeared, tinea corporis has a different distribution and underlying cause in different places. *T. rubrum* is Since it sprawls out from under

those who have tinea pedis, it is most likely the most frequent cause in the globe. The most frequent cause of tinea capitis in regions where the ailment is prevalent is *T. tonsurans*, is also the cause of tinea corporis. *M. canis* is usually to blame if a pet is the source of the spread. Other troublesome dermatophytes are *T. verrucosum*, *E. floccosum*, *T. mentagrophytes*, and *M. audouinii*. [46,47].



Figure (1): Tinea corporis

5-2-Tinea capitis (lashes, eyebrows, and scalp)

Tinea capitis is the term for a fungal infection of the scalp hairs. Additional terms for tinea capitis include ringworm and herpes tonsurans infection. [48]. The primary offenders are the dermatophyte species *Microsporum* and *Trichophyton*. The fungus can potentially penetrate the hair shaft and pierce the outer root sheath of hair follicles. Clinically, there are two forms of tinea capitis: inflammatory and non-inflammatory. Scarring alopecia is usually not a problem for the non-inflammatory form. The inflammatory kind may cause scarring alopecia and kerion, which are painful nodules filled with pus. [49]. Though it can affect anyone of any age, children between the ages of 3 and 14 are the most commonly affected by tinea capitis. It might also affect the eyebrows and eyelashes. *T. tonsurans* was the culprit causing tinea capitis instances., followed by *M. canis* and *M. audouinii*. *T. mentagrophytes* var. *granulare*, *M. gypseum*, while *T. rubrum* was less common isolates [50,51].



Figure (2): Tinea capitis

5-3-Tinea Cruris (Jock Itch)

Additionally recognized as tinea cruris, is a dermatophyte infection of the groin. Men are more prone to develop this dermatophytosis than women., which is commonly linked to tinea pedis. High levels of humidity and ambient temperature might cause tinea cruris. Occlusion from wet or tight clothing creates a perfect environment for infection. In a 1992 investigation, Chakrabarti et al. looked at 60 patients who had a medical suspicion of having tinea cruris and discovered that the most typical causes were *T. rubrum* [52,54].



Figure (3): Tinea cruris

5-4- Tinea Barbae (beard and mustache)

Tinea barbae is an uncommon dermatophyte disease that affects the skin, hair, and hair follicles of the beard and mustache. [55]. In 1842, Gruby made the initial diagnosis of tinea barbae, describing it as a fungal infection of the area around the beard, where the fungi formed a continuous sheath around the hair. The fungus was named "mentagrophyte," or "chin plant," by Gruby. [56,57]. The most prevalent representation of these pathogens is anthropophilic, however in rare instances, zoophilic dermatophyte forms can also be the cause. *Trichophyton rubrum* [58].



Figure (4): Tinea barbae

5-5- *Tinea Pedis (Athlete's Foot)*

The plantar surface of the foot and the crevices between the fingers are the main areas affected by tinea pedis, a fungal infection. According to estimates, around 70% of people will experience tinea pedis at some point in their lives. Males are more likely than females to get tinea pedis, with the maximum frequency occurring in those between the ages of 31 and 60.[58,59]. Numerous dermatophyte fungi, such as *Trichophyton rubrum*, *T. interdigitale*, and *Epidermophyton floccosum*, can cause tinea pedis. There are three primary clinical types of tinea pedis that are identified: hyperkeratotic (moccasin-type), vesiculobullous (inflammatory), and interdigital.[60,61].



Figure (5): *Tinea pedis*

5-6- *Tinea imbricata*

Trichophyton concentricum is the substance that causes tinea imbricata, a superficial dermatophyte infection predominantly observed in tropical regions of Africa, South and Central America, the Far East, and the South Pacific. Large patches with polycyclic borders made of concentric rings of scaling are characteristic of it. Large plaques may eventually emerge from the lesions' peripheral spread, covering nearly the whole skin's surface—though the scalp, axilla, palms, and soles are typically unaffected. When completely grown, the concentric rings resemble parallel lines of scales that cover one another, much like roof tiles or shingles (the word "imbrex" means "shingle"). [62].

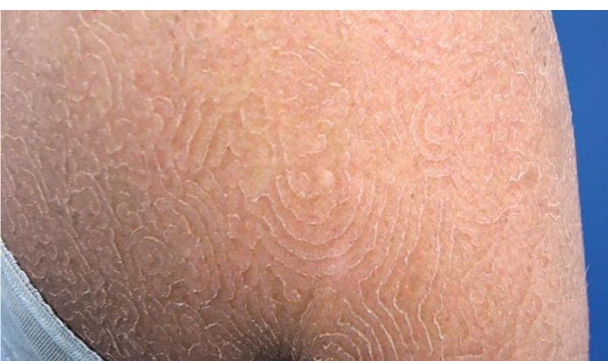


Figure (6): *Tinea imbricata*

5-7- *Tinea Unguium (onychomycosis)*

To put it simply, Onychomycosis is a nail infection brought on by yeast, mold, or dermatophytes. Another name for tinea unguium is nail dermatophyte infection. Onychomycosis can show with a variety of clinical invasion patterns. The most prevalent clinical form of distal lateral subungual onychomycosis is associated with *T. mentagrophytes* and *T. rubrum* organisms. Children's infection rates are thirty times lower than those of adults because their nails grow more quickly and have smaller surfaces. [63,64].

It may manifest in a variety of ways, including: Onychomycosis laterale. Subungual hyperkeratosis is the appearance of an opaque white or yellow stripe on one side of the nail. Undernail scaling is known as distal onycholysis. The nail's tip elevates. Frequently, the free edge breaks off due to superficial white onychomycosis. Proximal onychomycosis causes pits and flaky white spots to develop on the nail plate's upper surface. There are yellow patches on the half-moon (lunula), and the nail is completely destroyed. [65,66].



Figure (7): *Tinea Unguium*

5-8- *Tinea manuum*

T. rubrum, the most prevalent dermatophyte responsible for hand ringworm. Tinea manuum frequently presents clinically as dry and dispersed scaling lesions that accentuate the flexural folds of the hands. Inflammatory lesions are less prevalent but can nonetheless cause a prolonged reaction when other dermatophytes are included. [67].



Figure (8): *Tinea manuum*

VI. THERAPY FOR DERMATOPHYTOSIS

Today, dermatophytosis infections are treated topically with a variety of medications. The two most often used topical treatments for dermatophytosis are itraconazole (of the azole group) and terbinafine (of the allylamine group). [68]. The main issues with the use of recognized antifungal medications are long treatment durations, drug resistance, and even expense. [37].

Among the azole derivatives having antifungal qualities are imiconazole, miconazole, bifonazole, clotrimazole, ketoconazole, voriconazole, and fluconazole. The manner in which these compounds is the inhibition of a cytochrome (CYP) P450 involved in the manufacture of ergosterol, an essential component of the fungal plasma membrane. Systemic medicines are being used in the treatment of severe and persistent dermatophytosis. Nonetheless, the most widely utilized kind of antifungal treatment is topical imidazole medication, such as clotrimazole, ketoconazole, and miconazole. [69].

Traditional medicine has employed a variety of plants to treat fungal infections; researching these plants could aid in the creation of drugs that effectively combat dangerous fungi that infect humans. Many researchers were interested in conducting surveys and researching how various plant extracts affected different infections both in vivo and in vitro. [70].

VII. CONCLUSION

Dermatophytes are thought to be the main cause of cutaneous illnesses and have long been one of humanity's parasitic friends. Dermatophytes cause dermatophytosis when they target keratinized tissues such as the stratum corneum, nail, and hair because they are attracted to keratin. The field of dermatophytosis immunology is continually changing, with clear implications for the new immunological perspectives. Skin immunobiology offers many opportunities to improve our understanding of disease causes. One example of a cutaneous infection that is adaptable to its environment yet usually under control is dermatophytes. The use of plant-based remedies to treat fungal infections has attracted a lot of attention lately. This is because using medicinal plants has several advantages, such as reduced costs and fewer side effects.

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