

Identifying Signs of Tinea Pedis: A Key to Understanding Clinical Variables

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ABSTRACT

Tinea pedis is a frequently encountered dermatophytosis affecting the superficial skin of the feet, primarily of adults. The prevalence of tinea pedis has increased over the last several decades due to an increase in multiple risk factors. Infection from dermatophytes is most common, but infection from other fungi can also result in tinea pedis. Four distinct clinical presentations occur: interdigital, moccasin, vesicular, and acute ulcerative types. A variety of physical exam findings can help the clinician identify patients with tinea pedis.

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INTRODUCTION

Superficial cutaneous fungal infections represent a diverse group of diseases caused by dermatophytes, yeasts (*Candida albicans*), and occasionally non-dermatophyte molds. The prevalence of superficial cutaneous fungal infections has increased over the past several decades and is seen in both immunocompetent and immunosuppressed patients around the world.

Dermatophytes are a group of closely related fungi that infect the skin, hair, and nails of both humans and animals. Tinea pedis, the most common dermatophytosis, is a superficial fungal infection of the plantar surface and frequently occurs in developed countries. Although tinea pedis is caused mostly by anthropophilic dermatophytes, zoophilic infections can occasionally occur and these are usually more inflammatory.

Over the past 30 years there has been an increase in the incidence of tinea pedis due to in part to growing urbanization and changes in recreational activities; and currently up to 25% of the population may be affected at any given time in the United States.^{1,4} Tinea pedis can provide a portal of entry for secondary bacterial infection, resulting in profound complications and morbidity.⁵

Pathogenesis

Only a few fungi are implicated in the vast majority of tinea pedis cases (Table 1). *Trichophyton rubrum* is by far the most common organism involved in tinea pedis, followed by species from within the *T. mentagrophytes* complex, *Epidermophyton floccosum*, and *T. tonsurans*.⁶ Although *T. tonsurans* is an uncommon cause of tinea pedis in adults, its prevalence is increasing.⁷ Of these fungi, only species from within the *T. mentagrophytes* complex have both anthropophilic and zoophilic varieties; *T. rubrum*, *E. floccosum*, and *T. tonsurans* are strictly anthropophilic.⁸ In addition to being the most common cause

of tinea pedis, *T. rubrum* is also responsible for approximately 90% of onychomycosis cases.⁹ Chronic untreated or undertreated tinea pedis is a predisposing risk factor for the development of onychomycosis.⁹ Patients who progress from tinea pedis to develop concurrent onychomycosis have infections that are far more challenging to eradicate.

The taxonomic classification for the *T. mentagrophytes* complex has undergone multiple revisions over time as our ability to differentiate species based on molecular studies and genetic information has improved. Within the *T. mentagrophytes* complex, *T. interdigitale* (previously called *T. mentagrophytes* var. *interdigitale*) is the most commonly isolated organism. It is almost strictly anthropophilic, but can be found rarely in animals. Also within the *T. mentagrophytes* complex is the *T. mentagrophytes* species, which is primarily zoophilic and is found in association with rodents (rats, hamsters, guinea pigs), rabbits, and ferrets. In humans, the *T. mentagrophytes* species can cause a highly inflammatory form of tinea pedis. *Arthroderma benhamiae* is a third species within the *T. mentagrophytes* complex; however, this species will not be discussed here as it is primarily zoophilic and only occasionally leads to tinea corporis and tinea capitis, but not tinea pedis. Finally, *A. vanbreuseghemii* is a mating type strain within the *T. mentagrophytes* complex and will also not be discussed.

In addition to the dermatophytes mentioned above, infections from non-dermatophyte molds can also result in tinea pedis. Outside of the Western hemisphere, non-dermatophyte molds are not uncommon isolates from foot infections. For example, an outpatient epidemiology study from Thailand reported that non-dermatophyte infections account for nearly 60% of cases of tinea pedis.¹⁰ Of these non-dermatophytes, *Neoscytalidium dimidiatum* and its hyaline mutant *N. dimidiatum* var. *hyalinum* (previously called *S. lignicola*) represent the overwhelmingly

TABLE 1.

Fungi Implicated in Tinea Pedis	
Organism	Associated Features of Infection
Dermatophytes	
<i>Trichophyton rubrum</i>	Most common species to produce tinea pedis, strictly anthropophilic.
<i>T. mentagrophytes</i> complex <i>T. interdigitale</i> <i>T. mentagrophytes</i>	Most common within the <i>T. mentagrophytes</i> complex, strictly anthropophilic. Primarily zoophilic, infection results in highly inflammatory tinea pedis.
<i>Epidermophyton floccosum</i>	Strictly anthropophilic.
<i>T. tonsurans</i>	Strictly anthropophilic, isolated from pediatric tinea pedis.
Non-Dermatophyte Molds	
<i>Neoscytalidium dimidiatum</i>	Geophilic organism, endemic to Africa, Asia, the Caribbean, Central and South America, and several states in the United States. Infection is indistinguishable from dermatophyte tinea pedis, but is highly treatment resistant.

most common fungi.¹¹ *Neoscytalidium spp* are common fruit tree pathogen in the tropics, and geophilic transmission to human hosts in tropical and subtropical areas is thought to occur via contact with contaminated plants and soil.^{10,12,13} *Neoscytalidium spp* are endemic to parts of Africa, Asia, the Caribbean, Central and South America, and several states in the U.S. Infection with *Neoscytalidium spp* results in chronic, treatment resistant tinea pedis, tinea manuum, and onychomycosis infection that is clinically indistinguishable from cases associated with dermatophytes.

While tinea pedis is predominantly a disease that affects adults, tinea pedis can occur in children and is associated with a distinct mycologic profile in children. *T. tonsurans* is implicated in pediatric tinea pedis cases, especially when patients have concurrent tinea capitis caused by this organism. Children can also be infected with the typical dermatophytes that affect adults via household contact with fomites.

"Chronic untreated or undertreated tinea pedis is a predisposing risk factor for the development of onychomycosis."

Infection starts when the dermatophyte arthroconidia adheres to the superficial layer of the host's epithelium, after which hyphae develop and penetrate deeper into the epithelium. *T. rubrum* can survive outside of the human host as an arthroconidia for only a short period of time, whereas *E. floccosum* can survive for years on fomites.¹⁴ Because sebaceous glands are absent on acral skin, and their secretions are thought to have antimicrobial properties, palms and soles are the primary sites of infection. Infection is limited to the stratum corneum, which is a keratin-rich structure. Keratin is a hard, densely packed protein. Dermatophyte growth is fueled by the ability of these

organisms to degrade and use keratin via specialized enzymes: keratinase, cysteine dioxygenase, and a sulfite efflux pump.¹⁵ These enzymes represent a major virulence feature of dermatophytes.

Epidemiology

Tinea pedis is a relatively new infection in the Western world, transported through global human migration in the end of the nineteenth century. *T. rubrum*, which is the most common cause of tinea pedis, is endemic to Southeast Asia, Western Africa, and parts of Australia.¹⁴ Interestingly, tinea pedis was not endemic in these areas at the time of its spread, probably due to the fact that people in these areas did not routinely wear occlusive footwear, which is a major risk factor for tinea pedis.

European colonization of regions with endemic *T. rubrum* is believed to be how tinea pedis was first introduced to Europe. Subsequently, *T. rubrum* infection spread throughout Europe. The first case of *T. rubrum* tinea pedis in the U.S. was documented in a World War 1 veteran in Birmingham Alabama.¹⁶ Once a rare disease, tinea pedis is now the most common dermatophyte infection.

TABLE 2.

Risk Factors for Tinea Pedis

Uncontrollable Risk Factors

Male gender.

Medical history of immune suppression, diabetes, or peripheral vascular disease.

Dermatologic conditions, including a history of psoriasis or atopic dermatitis.

Controllable Risk Factors

Wearing occlusive footwear.

Exercising in public sports facilities, especially in community swimming pools, without wearing protective footwear.

Tinea pedis generally affects adolescent and adults. Predisposing host factors include male gender, wearing occlusive shoes, and living in a warm and humid climate (Table 2).² A medical history of immune suppression, diabetes mellitus, or peripheral vascular disease also place patients at an elevated risk for tinea pedis.² Exercising in public sports facilities, especially in community swimming pools, represent well-documented risk factors for contracting tinea pedis, particularly for men over the age of 16.¹⁷ Patients who cohabit with individuals affected by tinea pedis are also at risk for developing tinea pedis as transmission can occur from contact with fomites, most commonly in the bath.⁸ There is also evidence to support that tinea pedis is more common in patients with certain dermatologic conditions such as psoriasis or atopic dermatitis.¹⁸

Clinical Presentation

Patients with tinea pedis may present with one of 4 possible distinct clinical patterns: interdigital type, moccasin type, vesicular type, or acute ulcerative type (Table 3). Patients may complain of extensive pruritus or malodor; however, a significant proportion of patients have occult disease with an asymptomatic infection.

Patients with interdigital tinea pedis, which is the most common clinical presentation, develop macerated skin in the web spaces, most commonly in lateral 3rd and 4th interdigital web spaces (Figure 1). Contiguous skin may also be affected; however, the

FIGURE 1. Interdigital type of tinea pedis. Macerated skin in the lateral 3rd interdigital web space.



dorsal foot surface remains unaffected. Patients with this pattern of infection, if left untreated, develop macerated fissures and erythema. Warm and humid climates and hyperhidrosis are strong risk factors for this variety of presentation. *T. rubrum* and *E. floccosum* are commonly implicated pathogens. Highly macerated cases of interdigital tinea pedis can develop bacterial secondary infection, and this presentation has been termed dermatophytosis complex.¹⁹ The name comes from the fact that although the dermatophyte infection is the inciting factor for this disease, secondary candida and bacterial infection may arise and complicate the clinical presentation. Overgrowth of *Micrococcus sedentarius*, *Brevibacterium epidermidis*, *Corynebacterium minutissimum*, *Pseudomonas*, or *Proteus* can produce dermatophytosis complex.¹⁹

TABLE 3.

Clinical Presentation of Tinea Pedis

Clinical Pattern	Details of Presentation
Interdigital	Most common type of tinea pedis: patients present with macerated skin, with or without erythema and fissures, in the interdigital web spaces between the 4 th and 5 th toes.
Moccasin	Second most common type: patients present with dry, hyperkeratotic scales and fissures on the plantar surface of the feet. Collarets of scale can be seen along the borders of the feet. This presentation can be associated with concurrent tinea manuum, and may be asymptomatic.
Vesicular	Small vesicles over a background of erythema on the instep of the foot. This presentation can be painful or pruritic and develop rapidly; and is associated with zoophilic infection.
Acute ulcerative	This presentation results from an exacerbation of interdigital tinea pedis, and patients present with ulcers and erosions in the interdigital web spaces. Patients are at risk for secondary bacterial infections.

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Moccasin type is the second most common clinical presentation of tinea pedis, and is typically caused by *T. rubrum*. Patients with the moccasin type of tinea pedis develop chronic, dry, hyperkeratotic scale and fissures on the plantar surface of one or both feet. Collarets of scale can extend superiorly along borders of the feet in a "moccasin" type distribution (Figure 2). Occasionally patients can develop profound hyperkeratosis and fissures. Patients with this type of infection are most often asymptomatic and unaware that the infection is present. The moccasin type of tinea pedis may be associated with concurrent tinea manuum infection, and so an examination of the patient's hands is prudent. These patients may present with the so-called 2 feet-1 hand syndrome, where there is bilateral tinea

FIGURE 2. Moccasin type of tinea pedis. Collarets of scale on the lateral surface of the foot.



FIGURE 3. Tinea manuum and onychomycosis in a patient with tinea pedis. The presence of tinea manuum and onychomycosis increase the likelihood of concurrent tinea pedis.



pedis and a single hand with tinea manuum; or alternatively with 1 foot and 2 hands affected (Figure 3). Prolonged moccasin type of tinea pedis is a major risk factor for developing onychomycosis.

A less common presentation of tinea pedis is the vesicular type of tinea pedis where patients develop small vesicles on a background of erythema localized to the instep or medial plantar surface of their feet. These lesions are painful and pruritic, and develop far more rapidly than the other varieties of tinea pedis. Vesicular type of tinea pedis is the only subtype of tinea pedis that is exclusively associated with infection from organisms from the *T. mentagrophytes* complex infection, typically the zoophilic species.¹⁴

The acute ulcerative type is very rare and typically results from an exacerbation of the more common interdigital tinea pedis. Patients with acute ulcerative tinea pedis will present with ulcers and erosions in the web spaces between their toes, and these patients are at risk for secondary bacterial infection, which can be severe and debilitating. Patients may progress to develop cellulitis, lymphangitis, and fevers. The zoophilic variety of *T. interdigitale* is also implicated in this type of tinea pedis.¹⁴ Patients presenting with this type of tinea pedis are more likely to have concurrent diabetes, immunosuppression, or peripheral vascular disease.

In addition to the above mentioned clinical patterns of infection, a noteworthy proportion of people are carriers of the dermatophytes implicated in tinea pedis. In epidemiological studies, up to 14% of patients may have occult tinea pedis as defined by “normal” appearing feet, no symptoms concerning for tinea pedis, and a positive mycologic culture from scrapings of feet.²⁰ Clinical findings of tinea pedis can be subtle, especially for moccasin type tinea pedis, which may have only a fine collarette of scale. Although not a distinct subtype of tinea pedis, it is still important for the clinician to be aware of the concept of occult tinea pedis because it is quite common. Patients with occult infection may be considered to have an early stage of tinea pedis and are at risk of transmitting the infection to other people.²⁰ In one study, the overwhelming majority of patients with occult tinea pedis had onychomycosis; thus, patients with onychomycosis without clinical signs of tinea pedis ought to be evaluated for occult tinea pedis.²⁰

A variety of clinical exam findings should alert the clinician to the fact that a patient may have tinea pedis (Table 4). Patients who have either tinea manuum or tinea cruris should be examined for possible tinea pedis, as these infections often coexist. Similarly, as mentioned above, patients who have onychomycosis of either the fingernails or toenails should be evaluated for tinea pedis. Indeed, only patients with occult or clinically present tinea pedis will develop onychomycosis, so all patients with onychomycosis should be evaluated for evidence of tinea pedis.²¹

Differential Diagnosis

The differential diagnosis for tinea pedis includes both infectious and non-infectious etiologies (Table 5). Intertrigo with secondary bacterial or candidal infection can masquerade

TABLE 4.

Clinical Clues for Tinea Pedis Infection

Tinea manuum on one or both hands

Tinea cruris

Presence of onychomycosis on fingernails and/or toenails

TABLE 5.

Differential Diagnosis for Tinea Pedis

Disease	Distinguishing Features
Intertrigo from bacterial or Candidal infection	Typically presents with more striking erythema when compared with tinea pedis, and is also often found concurrently in multiple intertriginous areas.
Erythrasma	Will fluoresce coral red with examination under a woods lamp, while tinea pedis will not fluoresce.
Psoriasis	Patients will typically have psoriatic lesions elsewhere. However, patients with psoriasis can also have tinea pedis, so clinicians must maintain a high level of suspicion for this infection.
Dyshidrotic eczema	Patients often have a history of dyshidrosis, and lesions will be highly pruritic.
Shoe contact dermatitis	Dorsal foot is involved for shoe dermatitis, an area which is spared in tinea pedis.

as tinea pedis. Erythrasma is also on the differential diagnosis for tinea pedis. Examination of the feet with a woods light can help differentiate between erythrasma and tinea pedis as *Corynebacterium minutissimum* fluoresces coral-red while the dermatophytes implicated in tinea pedis do not fluoresce. Non-infectious differential diagnoses include psoriasis affecting the plantar foot, as well as dyshidrotic eczema if blistering is present on the foot. Shoe contact dermatitis must also be differentiated from tinea pedis; shoe dermatitis often affects the dorsal surface of the foot, while tinea pedis primarily affects the plantar and interdigital spaces.

Clinical Evaluation and Treatment

The diagnosis of tinea pedis should be confirmed prior to initiating treatment. A scraping from the plantar surface and interdigital space should be examined microscopically with potassium hydroxide (KOH) preparation for identification of fungal elements. Fungal culture is an academic exercise and not routinely performed, as identifying the fungal species will not alter treatment decisions.

Both topical and oral agents are available. As is true for other superficial mycological infections, tinea pedis should be treated with topical antifungal medication unless the infection is extensive and treatment-resistant. Patients should also be advised to disinfect their shoes and keep their feet clean and dry, wearing fresh socks daily, as these activities will diminish the risk of re-infection and improve the chances of a cure.

CONCLUSION

Tinea pedis is a very common condition that primarily affects adults. Four presentations are possible, including interdigital type, moccasin type, vesicular type, and ulcerative type. Patients may be asymptomatic and have occult infection; so it is important for the clinician to evaluate patients' feet for evidence of infection.

Successful treatment and eradication of tinea pedis can be challenging but is an important therapeutic goal. It is imperative to treat with topical antifungals as recommended by

manufacturers since inadequately treated tinea pedis is likely to return. Chronic untreated or undertreated tinea pedis greatly increases a patient's risk of progressing to developing onychomycosis, which can be even more difficult to cure. Patients often self-discontinue treatment when their symptoms of tinea pedis have resolved. Educating both patients and internists who treat tinea pedis on the importance of continuing treatment for the entire recommended treatment period will greatly facilitate successful treatment of tinea pedis and lessen the risk of a patient developing complications from their infection.

DISCLOSURES

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