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Clinical Forms of Dermatophytosis (Ringworm Infection)

Hugo Degreef

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Abstract Dermatophytic infections of the skin, hairs and nails are very common and are very variable in aspect. In skin, inflammatory symptoms are often absent, but in other cases they may be very pronounced, in particular when caused by zoophilic dermatophytes. In onychomycosis, it is very difficult to make the differential diagnosis with other causes of onychodystrophy on purely clinical grounds; indeed, even in case of fungal infection, the causative agent can be suspected on clinical grounds only in a minority of cases. The clinical presentation of skin infections, infections of the scalp and beard, and the nails are presented more in detail.

Keywords Dermatophytosis · Onychomycosis · Tinea barbae · Tinea capitis · Tinea corporis · Tinea cruris · Tinea manus · Tinea pedum

Introduction

The clinical aspect of dermatophytosis is very variable and results from a combination of keratin destruction and an inflammatory host response.

H. Degreef (✉)
Department of Dermatology, University Hospital, Katholieke Universiteit Leuven, Herestraat 49, 3000 Leuven, Belgium
e-mail: hugo.degreef@skynet.be

Important factors leading to the different clinical forms are the infecting fungus (zoophilic fungi tend to cause a more inflammatory reaction than anthropophilic dermatophytes), the site of the body infected and the keratinisation at that site, as well as the immune status of the host. We will follow the traditional division of dermatophytosis according to the site of the body infected, but also giving attention to the keratinisation at the site [1–3].

In this way, we can make a first division of infections of the glabrous skin (tinea corporis, tinea cruris, tinea faciei), the highly keratinised skin (palms, soles), skin rich in terminal hair follicles (tinea capitis, tinea barbae) and nail infections.

Tinea Corporis (Ringworm of the Body, Tinea Circinata)

This ringworm is the typical infection of the exposed glabrous skin and can be caused by all known dermatophytes, but the prevailing fungi in a particular region are likely to be the most frequently found infective agents.

The characteristic lesion is a circular, usually sharply marginated pink to slightly erythematous patch with a raised edge (Fig. 1).

As the lesion progresses, central clearing occurs and the lesion takes an annular shape. The advancing border is more or less scaling, but in inflammatory forms, in general caused by zoophilic or geophilic

Fig. 1 Tinea corporis, typical ringworm, in a young girl, caused by *Microsporum canis*

dermatophytes, crusts, vesicles, papules or even pustules can develop (Fig. 2).

Single lesions occur, but there may be multiple patches. By coalescence, bizarre configurations can be formed.

Not all cases of tinea corporis reveal the characteristic features described above. Central clearing may be lacking. Scaling of the active border may be almost absent, and redness may be minimal. Infections with *Trichophyton rubrum* (*T. rubrum*) can take this aspect with very chronic, non-inflammatory, extensive lesions [4, 5].

Tinea corporis must be differentiated from other dermatoses with an annular aspect (nummular eczema, psoriasis, pityriasis rosea, granuloma annulare, erythema chronicum migrans, sarcoidosis). In case of doubt, direct microscopic examination of a KOH preparation will give the answer by visualizing the hyphal elements.

Fig. 2 Tinea corporis, inflammatory type, caused by *Trichophyton verrucosum*, in a farmer. Above the knee there is a follicular tinea corporis

Follicular tinea tends to occur when a cutaneous dermatophyte infection such as tinea corporis is exposed to occlusion or repeated superficial trauma, such as shaving of the skin. The eruption may present as an erythematous plaque with follicular papules or pustules. Erythema tends to be deeper than with classic tinea corporis ("ringworm"). **Majocchi's granulomas** are typically situated on the legs and caused by *T. rubrum*. They tend to be more infiltrative and may sometimes present as an inflammatory nodule or soft nodular and pustular plaque. Application of topical corticosteroids to a dermatophyte infection such as tinea corporis or tinea manuum, may promote a deeper follicular invasion by the fungus [6].

Tinea imbricata (Tokelau) is a superficial fungal infection essentially limited to Southeast Asia, India, Central America and Southwest Polynesia. The causative organism is the anthropophilic *T. concentricum*. The skin lesions are characteristically concentric and lamellar plaques of scale, resembling erythema gyratum repens [7].

Tinea corporis gladiatorum often manifests on the head, neck, and arms, which is the distribution consistent with the areas of skin-to-skin contact in wrestling [8].

Tinea incognito is a tinea corporis whose appearance has been modified by the application of mild to high potency corticosteroids. In most cases, the annular scaling and the circumscribed borders are absent, leading to a diffuse erythema with follicular papules and pustules. These are caused by intrafollicular invasion by the fungus (see also follicular tinea) [9].

Tinea Cruris

Tinea cruris is an acute to chronic inflammatory reaction of the skin of the inguinal region caused by dermatophytes. Tinea cruris is common; adults are much more infected than children and the disease is three times more common in men than in women. The disease is worldwide distributed, but it is found more commonly in hot climates. Also tight-fitting, sweaty or rubbing clothing or tight clothing or undergarments are favouring factors.

Trichophyton (*T.*) *rubrum* is the most common etiologic agent, but *T. interdigitale* is not rare. In addition, *Epidermophyton* (*E.*) *floccosum* is now rarely involved. However, in the previous century, this dermatophyte species was a very common agent of the disease, and it was even known under the name of *E. inguinale*. Other dermatophyte species can be isolated exceptionally.

An acute inflammatory reaction is often associated with *T. interdigitale* (*T. mentagrophytes var. interdigitale*). Conversely, infections with *T. rubrum* are in general less inflammatory and apt to become chronic.

Autoinoculation from tinea pedis or tinea unguium is common, but infections transmitted from fomites (towels, sheets) are also possible.

The lesions can begin unilateral, but very soon both groins are affected. Patches with erythema with central clearing are centred on the inguinal creases and take a semicircular aspect. Extension occurs both distally on the medial part of the tights, and proximally to the lower abdomen and pubic area, the perineum and buttocks. The peripheral activity is characterised by fine scaling and the presence of some papules and pustules. The borders are sharply demarcated. In the more acute forms, the lesions may be moist and exudative or can have an eczematous aspect (historical name:eczema marginatum Hebra). In the chronic form, the lesions are dry with an annular or arciform aspect, some papules or small follicular nodules may be present and scaling is barely perceptible. During the progression of the patches, the central erythema fades and hyperpigmentation is quite typical.

Tinea cruris causes itching or a burning sensation and by rubbing and scratching, lichenification or impetiginisation can complicate the condition [10].

The differential diagnosis with intertriginous candidiasis, erythrasma, intertrigo and irritant or allergic contact dermatitis must be made. In candidiasis of the groins, the lesions are moist, deep red, with some typical satellite pustules. There is no central clearing and increased inflammation of the borders, and the scrotum is commonly affected. In erythrasma which is caused by *Corynebacterium minutissimum*, the lesions are uniform in colour, red to brown, and there is no scaling or central clearing. The borders are sharply demarcated, but not infiltrated. Intertrigo is an inflammation of the larger body folds. Obesitas, diabetes and friction are predisposing factors. The skin is red, sometimes weeping and secondary infections with yeasts or bacteria are common.

Tinea Faciei

Tinea faciei represents "tinea corporis of the glabrous skin of the face". Although the lesions can have the typical aspect of a tinea corporis, more often the redness and the scaling border are less pronounced (Fig. 3). More than one patch can be present. Therefore, the lesions are not always suggestive for a dermatophyte infection and various other dermatoses have to be considered (seborrhoeic dermatitis, discoid lupus, rosacea, contact dermatitis, …).

This misleading aspect supports the separation of the disease from tinea corporis. The causative agents vary according to geographic regions, but in general the source of the infection is a zoophilic reservoir in animals and pets (Fig. 4) or extension from an infection elsewhere on the body [11].

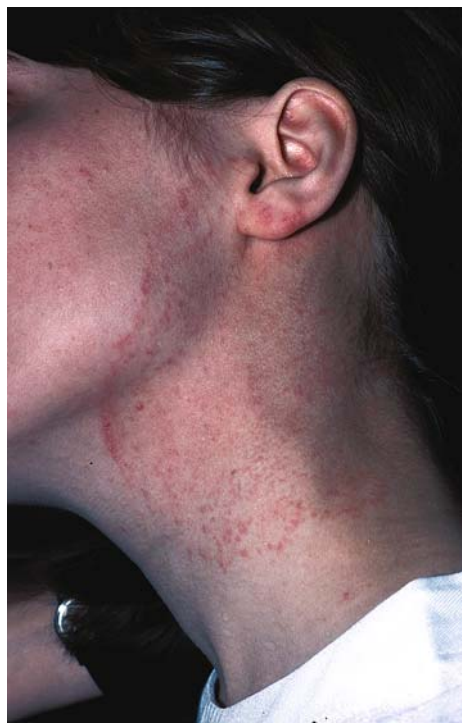

Fig. 3 Tinea faciei in a young immunocompromised girl caused by *Trichophyton rubrum*

Fig. 4 Inflammatory tinea faciei caused by *Trichophyton mentagrophytes*

Tinea Pedis (Foot Ringworm, Athlete's Foot)

The anatomical characteristics of **keratinised skin** [12] are very important in understanding the clinical manifestations of fungal infections. The skin of the palms and soles has a thick horny layer and is rich in eccrine sweat glands, although hair follicles and sebaceous glands are absent. Most inflammatory reactions result in vesicular-bullous, or even pustular lesions. Lack of inflammation is characterised by pink to red discoloration and diffuse scaling. The clinical manifestations are also influenced by external conditions such as hot, moist climates, hyperhidrosis and wearing shoes. These factors predispose to more inflammatory lesions. The causative fungi will also influence the clinical presentation of infection. *Trichophyton rubrum* is often associated with chronic, non-inflammatory erythematosquamous reactions. Infections due to *T. mentagrophytes* var. *interdigitale* often lead to vesicular or bullous inflammatory lesions. *Epidermophyton floccosum* may produce both types of reactions, but infect significantly less toenails. Indeed, nail involvement is very common with the former mentioned dermatophytes. The three already mentioned anthropophilic species are most commonly associated with tinea pedis, although other dermatophytes may also be involved in tinea pedis and tinea manus. In tinea manus, *T. rubrum* is by far the commonest cause. Double infection with any of these two species can be seen in tinea pedis. There may be a genetic predisposition for the plantar type of tinea pedis, caused by *T. rubrum.* This genetic predisposition is known as the "two feet-one hand syndrome" indicating that not only both feet are infected with *T. rubrum*, but also the skin of one (two) hand and in many cases also the toenails and/or fingernails.

Tinea pedis is the commonest form of dermatophyte infections in developed countries. The interdigital type is the most common subtype. However, even in the other clinical subtypes, interdigital involvement is often found and is indicative for the diagnosis of foot ringworm.

Interdigital Tinea Pedis

Interdigital tinea pedis, commonly referred to as "athlete's foot", is a dermatophyte infection involving the web spaces of the feet. Some or all web spaces are involved, with the space between the fourth and fifth toes most commonly affected. The clinical presentation may be characterised by dryness, scaling and fissuring or by white, moist maceration. Irritation and itching are often present (simplex type). Secondary maceration with overgrowth of the bacterial flora commonly complicates the eruption leading to an inflammatory "mixed" process (complex type) [13]. When significant maceration is present in the web spaces, it becomes more difficult to identify the fungal organisms on KOH preparation. In some cases, the dermatophyte infection may extend onto the dorsal surface of the foot presenting as a typical tinea corporis with chronic dry annular eruption with an advancing scaly demarcated border.

Vesicular Type of Tinea Pedis (Dyshidrotic Type)

A vesicular or dyshidrotic reaction of the sole often appears in patients suffering for months or years with interdigital tinea pedis. Hot, humid climatic conditions may be the eliciting factor. This vesicular reaction may be limited. Vesicles may rupture, leaving a fine collarette, scaling and then heal spontaneously. When new vesicles appear, the clinical aspect of healing and vesicular lesions can take an eczematous appearance.

In the differential diagnosis of dyshidrotic lesions, atopic or allergic contact dermatitis and hyperhidrosis with pitted keratolysis must be excluded. Pustular lesions must be differentiated from pustular psoriasis or palmoplantar pustulosis. An acute inflammatory vesicular tinea pedis may be accompanied by a

vesicular, allergic reaction (*mycide reaction*) of the hands. This pompholyx-like reaction is only seen in severe, acute inflammatory tinea.

Chronic, Erythematosquamous Tinea Pedis (Moccasin Type)

In the mildest form, a few small scaly collarettes can be found. In more severe forms, diffuse, dry silvery white scaly lesions, covering a mild pink to red inflamed skin, are present. In the most severe cases, the soles, heels and sides of the feet are affected. The patients complain of a dry, scaling skin, resistant to emollients. This type is also known as "moccasin foot". Occasionally, the lesions may become really hyperkeratotic. In most instances, both feet are affected, but the infection may be unilateral. Involvement of the dorsum of the foot is rare, but onychomycosis is common. Dorsal tinea pedis is mainly situated above the interdigital spaces. The skin can be eczematous, or identical to ringworm of glabrous skin.

Chronic tinea pedis must be differentiated from chronic eczema and psoriasis. In children, one must consider the possibility of juvenile plantar dermatosis. In this disease, the skin is dry, chapped and often fissured. The contact surface of the big toe and the weight-bearing parts of the sole and heel are affected. Chronic tinea pedis is rare in children. In hyperkeratotic forms, a differential diagnosis with hereditary keratosis palmoplantaris must be made. Although this condition is rare, secondary invasion by fungi is possible.

Tinea Manus (Dry Type, Inflammatory Type)

Ringworm of the palm of the hands (tinea manus) [12] is quite rare and typically only affects one hand. If both hands are affected, the term "tinea manuum" is used. *Trichophyton rubrum* is the commonest infecting dermatophyte, and in most cases, there is a pre-existing foot infection, with or without nail involvement (two-feet-one-hand-syndrome).

T-cell immunodeficiency against *T. rubrum* has been suggested in these patients. Usually the clinical presentation of tinea manus consists of diffuse dry scaling lesions, with accentuation of the flexural creases of the palms (Fig. 5). As *T. rubrum* is the most common infecting agent, a chronic reaction can be expected, but less frequently, inflammatory (vesicular or pustular) lesions can be found when other dermatophytes are involved. Irritant and allergic dermatitis of the hands or palmar psoriasis are much more common than tinea manus and are typically bilateral.

Fig. 5 Tinea manus, chronic infection, caused by *Trichophyton rubrum*

Tinea Nigra (Pityriasis Nigra, Keratomycosis Nigricans Palmaris)

Although it is not caused by dermatophytes, tinea nigra needs to be presented here. Symptoms of this superficial fungal infection of the palms, consist typically in a solitary brown to black non-scaling macule on the palms, occasionally on the soles or elsewhere [12]. There is no inflammation. Infections have been reported worldwide, but are more common in tropical regions. Infection is believed to occur as a result of inoculation from a contamination source (such as soil, sewage, wood, or compost) subsequent to trauma in the affected area. The causative agent is *Hortaea werneckii* [syn. *Phaeoannellomyces* (*Exophiala*) *werneckii*], a saprophytic fungus believed to occur in soil, compost, humus and on woods in tropical and subtropical regions. In some cases, other species of dematiaceous fungi, such as *Stenella araguata*, may produce a similar clinical picture.

Tinea nigra is a benign disease that can easily be cured with topical antifungals, but its importance resides in the differentiation of potentially life-threatening diseases like malignant melanoma. Direct microscopic examination from skin scrapings reveals

branched brown hyphae with light brown septae. The pigmentary changes in the skin are due to the accumulation of melanin-like substances in the fungus.

Tinea Capitis (Scalp Ringworm)

Once very common, hair infections due to dermatophytes are now rather rare in Western Europe and in the US, although in prepuberal children they still cause problems [14–17]. However, there is an impression that the frequency is increasing again in the last decade, probably due to emigration and immigration, and to the easiness of international travelling. In some urban areas in North America, Central and South America, tinea capitis is widespread and is still very common in parts of Africa and India.

The infection can be located on the scalp, eyebrows, or eyelashes. The causative agents are fungi of the genera *Trichophyton* and *Microsporum*.

Some dermatophytes grow endothrix, inside the hair shaft, characterised by an invasion of chains of large spores. The cuticle surface of the hair remains intact. Endothrix tinea capitis is caused by anthropophilic fungi. Infected hairs break off sharply at the follicular orifice, leaving a black dot. The aspect of the infected area is that of a *tonsure*, a common practice of clerical or monasteric clergy until 1960.

Other dermatophytes grow ectothrix, meaning that multiple arthroconidia also surround the hair shaft and the cuticle is destroyed. Ectothrix tinea capitis is caused by zoophilic fungi, including *T. mentagrophytes* from rodents and rabbits and *T. verrucosum* from cattle, although anthropophilic forms exist. All species of *Microsporum* are also ectothrix growing.

T. schoenleinii infections of the hairs are characterised by hyphae and air in the hair shaft. This fungus is an anthropophilic fungus nowadays rare in Western countries, which causes a special scarring form of tinea capitis, known as "favus".

Tinea capitis can be divided into microsporosis, trichophytosis, and favus.

Microsporosis

The primary lesion is a small red papule around a hair shaft, later on becoming paler and scaly, with a dystrophic aspect of the hair. By peripheral extension arises the typical non-inflammatory or dry type tinea capitis, an area with hair loss with mild scaling on an erythematous background (Fig. 6). The hairs break off 1–3 mm above the scalp.

More than one patch may be present and they can confluent to larger bald areas.

In most European countries, the anthropophilic *M. audouinii* has been replaced by the zoophilic *M. canis*. The infection is more common in young boys than in girls. The source of infection is in most cases not a dog, as the name suggests, but sick or asymptomatic cats and kittens. The infection can be transmitted from person to person, in the first place children, after short contact with an infected person or via cosmetic fomites.

Under Wood's lamp examination, microsporosis tinea capitis reveals a greenish fluorescence.

Trichophytosis of the Scalp

Trichophytosis of the scalp can be caused by endothrix or ectothrix growing fungi. The causative agents can be anthropophilic or zoophilic, the latter causing in general more inflammatory lesions. The anthropophilic, endothrix growing, *T. tonsurans* is now the most common pathogen in the United States. *T. violaceum* is common in Eastern Europe, Arabic Africa and the Indian subcontinent. In most cases, they cause dry non-inflammatory patches, more angular than round. Black dots can be seen, as the hairs break off at the opening of the follicle. Some folliculitis lesions may be present.

In very severe forms, a frank kerion may be formed. Kerion is a swollen mass, discharging pus.

Fig. 6 Tinea capitis kerion-type in a young boy caused by *Microsporum canis*

Bacterial infection with staphylococci is not rare and this type may cause a scarring alopecia. The lymph nodes in the neck may be swollen.

The zoophilic ectothrix species *T. verrucosum* and *T. mentagrophytes* cause in general more inflammation and kerions are often seen.

Favus

Favus which is a unique infection due to *T. schoenleinii*, is still endemic in South Africa, the Middle East and in some other regions. The infection is characterised by the formation of scutulae and a chronic evolution, ending in many cases in a scarring alopecia. Scutulae are yellow cup shaped crusts around the hair shafts. Adjacent crusts enlarge to become confluent and form a yellow crusting mass.

Tinea Barbae

In most cases, the zoophilic ectothrix fungi *T. verrucosum* and *T. mentagrophytes* are responsible for this type of infection in the beard and eyebrows of adult man and the clinical picture is that of highly inflammatory pustular folliculitis or kerions (Fig. 7), like in inflammatory trichophytosis of the scalp.

Fig. 7 Severe kerion celsi of the beard, in a farmer, caused by *Trichophyton verrucosum*

Nail Infections (Tinea Unguium, Onychomycosis)

Infections of the nails by dermatophytes (tinea unguium), yeasts or moulds are clinically almost indistinguishable on clinical aspect and, therefore, the general term of onychomycosis is often used [18–20]. Infections by dermatophytes are by far the most common cause. Toe nails and fingernails can be infected, but toenails are more often affected. All 10 nails can be infected, but it is not rare to see that some nails are spared.

T. rubrum accounts for 70% of all cases and *T. mentagrophytes* var. *interdigitale* for 20%. In rare occasions, other species are involved.

Tinea unguium (onychomycosis) can be divided in five subtypes:

Distal Lateral Subungual Onychomycosis

Distal lateral subungual onychomycosis is the most common subtype. The fungus invades the horny layer of the hyponychium and/or nail bed, then the under surface of the nail plate, which becomes opaque. This causes thickening of the horny layer raising the free edge of the nail plate, followed by secondary onycholysis. Discoloration ranges from white to brown (Fig. 8).

Endonyx Onychomycosis

Endonyx onychomycosis which has been described only recently [21], is a rare subtype of onyxis. The

Fig. 8 Distal and lateral subungual onychomycosis, caused by *Trichophyton rubrum*

infection which is due to *T. soudanense*, is clinically characterised by a diffuse milky-white discoloration and the absence of nail bed hyperkeratosis or onycholysis. Nail plate and nail thickness are normal. There is a clear contrast between the great invasion by hyphae in the nail plate and the absence of fungal elements in the nail bed.

Superficial White Onychomycosis

Superficial white onychomycosis is normally confined to the toenails and *T. mentagrophytes* var. *interdigitale* is responsible for more than 90% of the cases.

In the beginning, white patches with distinct edges on the dorsal nail plate are seen, but they can coalesce and eventually cover the whole nail. The surface becomes roughened and the texture softer than normal (Fig. 9).

Proximal Subungual Onychomycosis

Proximal subungual onychomycosis is a very rare subtype of finger and/or or toenail onyxis. The infection begins in the proximal nail fold. When it reaches the matrix, the fungus, usually *T. rubrum*, invades the lower portion of the nail plate and a white spot appears under the cuticle which advances distally. A rapid developing form can be regarded as a marker of immunodeficiency (i.e. HIV infection) and can involve all finger or toenails.

Total Dystrophic Onychomycosis

Secondary total dystrophic onychomycosis represents the most advanced form of onychomycosis. The nail crumbles and disappears, leaving a thickened, abnormal nail bed retaining keratotic nail debris (Fig. 10). In AIDS patients this evolution can go rapidly and can start from a proximal subungual onychomycosis.

Fig. 9 Superficial white onychomycosis, caused by *Trichophyton rubrum*

Fig. 10 Total dystrophic onychomycosis caused by *Trichophyton rubrum*

Primary total dystrophic onychomycosis is caused by *Candida* spp. in immunodeficient patients, in particular in chronic muco-cutaneous candidiasis.

Mixed Infections

Bacteria, yeasts or moulds can complicate tinea unguium. The clinical aspect including the colour can then be modified. The treatment of these infections is not always easy.

Conclusion

The diversity in clinical signs of dermatophytosis is so large that one has to remember that not all red, scaling skin changes, or hair diseases and dystrophic nails are caused by fungal infections. On the other hand, a given clinical aspect can be caused by different fungal species which could imply some specific treatments. Tinea capitis caused by *Trichophyton* spp. is relatively easy to treat, but when microsporosis is present, treatment is much more difficult.

Few new information has been published on the clinical aspect of dematophytosis of the skin, hairs and nails. Endonyx onychomycosis and the abnormal aspect and evolution in immunocompromised patients may be the exceptions.

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