Tinea Pedis: An Opportunistic Infection of The Skin

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In Japan, the average incidence of tinea pedis among dermatology out-patients is around 10%. Obviously this does not reflect the true invasion of dermatophytes on human skin. Several attempts to elucidate the incidence of tinea pedis among the population revealed nearly 40% of randomly chosen patients at dermatology clinics suffered from tinea pedis with an increasing incidence by age group. Furthermore, results obtained from regular medical checks of healthy adults at Nagasaki Municipal Hospital revealed more than 30% of the recruits had only a slight scaling of mild hyperkeratosis which could not be differentiated clinically from other pathological or even age-related changes. Nearly two-thirds of these tinea pedis lesions are left untreated, or even unnoticed as a disease. Several experiments to prove the presence of dermatophytes from healthy-looking skin revealed the possibility of the presence of subclinical lesions or carriers of dermatophytes accumulating around these tinea pedis patients. Uncontrolled tinea pedis lesions are a major cause of tinea unguium, which is expensive and time-consuming to cure especiallyin the aged. There are no standardized treatment modalities for tinea pedis patients focusing on the complete cure. But the difficulties to eradicate the pathogens from their host are common among opportunistic infections. Also the dissociation of the number of patients and the population having the pathogens without apparent lesions, i.e. healthy carrier, is a characteristic of opportunistic infection. Undetected tinea pedis patients are problematic since they are source of infection for others. Discovering and treating the hidden patients is becoming a public health problem, as well as a private hazard. Prevalence of pathogens in the host tissue and low mobility rate are a feature of opportunistic infections. The control methods for tinea pedis as an opportunistic infection should also be taken under consideration. **[Kor J Med Mycol 6(4): 207-212]**

Key Words: Tinea pedis, Prevalence, Anthropophilic dermatophytes, Opportunistic infection, Healthy carrier

1. Background

Regardless of the introduction of many new antifungal drugs in the market with brilliant therapeutic effects in clinical trials, the number of patients who visit dermatology clinics for the consultation on the treatment of tinea pedis lesions has remained unchanged for the past several decades.

There seems to be several reasons for the failure of the eradication of tinea pedis lesions or their causative pathogens from human bodies. The author reviews the present situation on the incidence of tinea pedis patients and the factors concerning difficulties with the control of tinea pedis in the human society.

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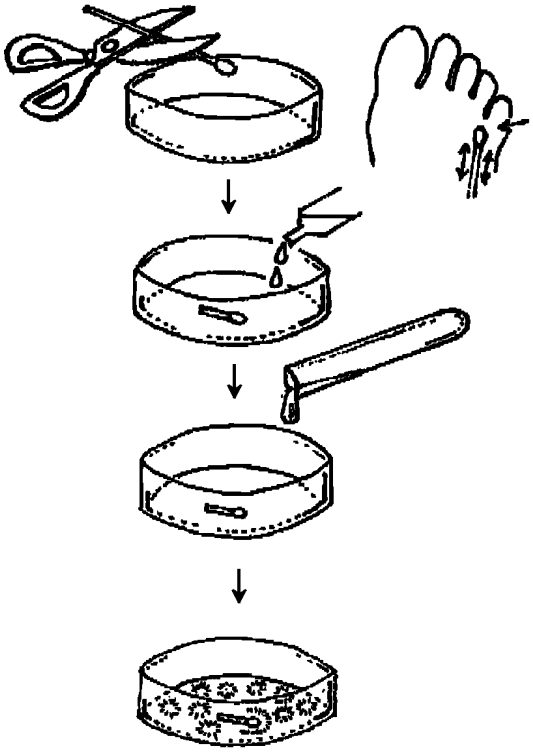
2. Difference of the incidence of tinea pedis patients between outpatients in the dermatology clinics and those found by screening medical examinations

The number of patients who visit dermatology clinics with a complaint of tinea pedis is far less than the actual population with tinea pedis. In Japan, the incidence of tinea pedis in the total outpatients of dermatology clinics is reported ca. 10%, higher in the South-western areas and lower in the Northern areas[1]. However the number of tinea pedis patients revealed by precise mycological examination during medical checks of healthy adults reached nearly 30% with a higher tendency in older age groups[2~4]. Some of them did not notice the existence of tinea pedis lesions on their feet. In many cases skin changes of these patients remained asymptomatic, at most with slight scaling of interdigital spaces or plantar areas, which could not be differenciated clinically from other pathological changes due to, such as, contact dermatitis or even age-related changes.

Similar results are obtained by other investigations, suggesting many patients failed to have a chance for complete healing or their skin lesions were not eradicated by the antifungal treatment they received. It is well known that tinea pedis lesions usually do not heal spontaneously.

Mycological examination on industry workers revealed an extremely high incidence of tinea pedis patients, nearly 70%, indicating hot and moist local conditions in protective shoes, which they are forced to wear during working, favoured the overgrowth of causative fungi of tinea pedis[5].

The difference in the number of tinea pedis patients between dermatology clinics and those found



1) Specimens are taken by rubbing the skin surface with a wet cotton swab, which is then placed in a Petri-dish.

2) Pour 2~3 ml sterile water into the Petri-dish and mix well.

3) Add 20 ml melted Sabouraud's dextose ager (ca.50℃) and stir gently.

4) Keep at room temperature and observe after 2~3 weeks.

Fig. 1. Schematic explanation of cotton swab sampling method

by medical examinations is due to the patients with subclinical tinea pedis lesions who do not ask for any medical interventions.

3. The extent of subclinial area around tinea lesions

As shown with the pliable tape method on tinea corporis and tinea cruris, pathogens are not confined within visible tinea lesions[6]. They are distributed beyond the border for several centimeters outside the tinea lesions. The same is proved with tinea pedis using the cotton swab sampling method (Fig. 1)[7,8]. The causative dermatophytes are detected from adjacent interdigital spaces or even from healthy looking unaffected feet of unilateral tinea pedis patients.

In other words, tinea lesions appear only on the skin where the density of dermatophytes exceeds the threshold to provoke immunological reaction of the host to shed off the parasites.

4. Tinea pedis patients among family members

When we examined children suffering from tinea lesions, i.e.tinea corporis or tinea pedis caused by anthropophilic dermatophytes, such as *Trichophyton rubrum* or *Trichophyton mentagrophytes* var. *interdigitale*, it is easy to find tinea pedis patients in their family, most often in the father.

To know the infestation of tinea pedis in a small group, such as in a family members, the author examined mycologically the healthy-looking children of tinea pedis patients, using the cotton swab sampling method and compared the frequency of isolation of dermatophytes betweeen the family with tinea pedis and those without. The results are shown in Table 1 that, though not statistically significant, the ratio of children from whose feet dermatophytes are isolated is higher in the families with tinea pedis patients than those without.

The presence of dermatophytes on the skin of the feet of these children may be a contamination by dermatophytes released from patients, however, there is at least a possibility that in the early decades of their life, they are already infected by the fungus but still remain at the stage of subclinical infection. It is reasonable to consider that the children are at a high risk of proceeding to symptomatic tinea pedis. Further study is needed on the outcome of these children by longterm follow-up examinations.

5. Ecological aspects of anthropophilic dermatophytes

The causative fungi of tinea pedis, dermatophytes, are characterized by their ability to utilize hard protein, keratin, which is a main component in the outermost layer of the skin of higher vertebrates, and at the same time to have the ability to parasitize on the skin, living almost exclusively in the stratum corneum[9].

The prerunners of the dermatophytes of present times are thought to have been able to survive in the soil utilizing their ability to digest keratin, playing a role as a decomposer of keratinous ma-

Table 1. Detection of dermatophytes from the "healthy" children using the cotton swab sampling method

	No. of dermatophytes "+" children (%)	No. of children examined
No. of families		
with tinea pedis patients	7 (21.3)	33
without tinea pedis patients	2 (7.4)	27

terial from animals living or dead. With continuing evolution, some of them further adapted to a parasitic life on the skin or its appendages of diverse animals, such as the horny layer, nail plates and hairs.

Some groups of dermatophytes found their own ecological niche on the skin of various, but specific, animal hosts. Humans are parasitized by several species of dermatophyte classified into three anamorph genera, *Microsporum*, *Trichophyton* (*T.*) and *Epidermophyton*. In addition to these, we are surrounded by several species of dermatophytes which parasitize animals, or live in the soil, but still retain, to some extent, the ability to parasitize to humans.

As a common rule between hosts and their parasites, the longer the contact between them, the milder the immunological reaction of the host to exclude the parasites from the host tissue. They are expressed as inflammatory reactions of the hosts against parasites to shed them off. This is, in other words, a tolerance from the standpoint of host to parasite and an adaptation from the parasite to their hosts. The final stage in development is commensalism or being members of normal flora. In this case, the parasites reside in the host tissue without provoking inflammatory response.

The pathogens of tinea pedis in Japan are *T. rubrum*, 60~70% in incidence, followed by *T. interdigitale*, 25~35%, and others. Among them, as shown with the frequency of isolation rate, *T. rubrum* is the most successful among human parasites. It is well known that the inflammatory reaction of tinea lesions caused by *T. rubrum* is milder when compared to those caused by other dermatophytes. The lesions found in medical checks of healthy adults or with mycological examinations performed on family members of the patients are usually very mild in inflammation and therefore they are left untreated or even unnoticed.

T. rubrum is very rarely found in animals other than humans. They are usually found on the human skin and in the environment surrounding humans. They present in the environment only as transients after being shed from the human skin. Their saprophytic life is difficult to proved in the environment.

In human skin, using the cotton swab method we examined and proved the presence of anthropophilic dermatophytes, mainly *T. rubrum*, on the healthy looking skin of the patients suffering from tinea pedis and their family members.

Furthermore the existence of dermatophytes were found on the skin of healthy individuals who had contact with a tinea patient.

However, it is shown by the cotton swab sampling method that the number of dermatophyte colonies counted per Petri-dish is usually less than 50. On the contrary, in the case of tinea pedis lesions, the number of colonies grown was more than 100/dish, sometimes several hundreds.

6. Conditions favorable to provoke tinea pedis lesions

The inflammatory lesions of dermatophytoses are the expression of type-IV or delayed type immunological reaction to shed off the causative pathogens from the host tissue, i.e. stratum corneum[10]. Visible lesions of dermatophyte infections are an expression of inflammatory reactions to exogenous antigens, dermatophytes and/or their products, which have penetrated via the stratum corneum.

The initial step for the establishment of tinea lesions is the adherence of dermatophytes to the surface of human skin. Thereafter they proliferate to invade the deeper layers of the stratum corneum. At this stage, the antigenous stimuli due to the presence of dermatophytes, are below the threshold for the initiation of the host defence mechanism. With continuous proliferation of dermatophytes under suitable environmental conditions the anti-

genic stimuli from the parasites increase and finally exceed the threshold in order to provoke a cascade of the immunological reactions leading to shedding of the parasites.

The conditions favorable for causing tinea pedis lesions are the same for inducing proliferation of the causative dermatophytes; temperature and moisture, for example, as in wearing tight foot gear for a long period of time. The anatomical structure which causes occulsive condition between toe webs is also important.

Retarded turnover period of stratum corneum is thought to be important as it offers a stable residence for the fungi adhered to the surface of human skin. Aging, neurological or vascular diseases cause prolonged turnover time.

7. Treatment of tinea pedis and the designed goal

The indication in textbooks for the treatment of tinea pedis is not sufficient because it only describes the names of drugs and how to apply them.

The important points for the dermatologist to determine are:

(1) Which treatment should be chosen, topical?, systemic?, or a combination?

(2) If a topical drug is chosen, then to which area should it be applied? Only to the lesions? If not, then how much wider?

(3) How long should we continue the treatment or when do we stop the treatment?

The causative fungi are not only present within tinea lesions but also around or adjacent to the lesions to some extent. The area is hard to determine because it may differ with each type of lesion, localization of lesions or by patient.

Recurrence is usual when we stop the treatment just after the disappearance of the lesions. If we set the goal of the treatment of tinea pedis as eradication, oral antifungal treatment is superior to topical use. Considering the adverse side effects of oral antifungal treatment, however, it is not practical to use oral drugs for all tinea pedis patients. Furthermore there are many aged patients who have difficulties in taking oral drugs for reasons of drug interactions, complicated gastrointestinal upset or liver dysfunctions.

8. Conclusion

As mentioned above, the characteristics of tinea pedis, i.e. localization of pathogens, responce and course after treatment and the high reccurence rate, are quite similar to those of candidiasis, a representative of endogenous opportunistic infection. Pathogens of candidiasis reside as a member of normal flora in the oral cavity, gastrointestinal or upper respiratory tracts and genitalia. Nearly 30% of healthy individuals bear this fungus in their oral cavity[11], the number is compatible to that found with the mycological examination on the presence of dermatophytes among normal subjects. They cause pathological changes only when they have a suitable condition to proliferate. After adequate treatment, they reduce their population and the lesions disappear. The treatment of these opportunistic infections is to reduce the number of pathogens and to recover the normal flora, not to eradicate them from the human body. The difficulties in eradicating the pathogens from their host are common among opportunistic infections.

The control of tinea pedis lesions is nescessary because uncontroled tinea pedis lesion are the major cause of tinea unguium, which is expensive and time-consuming to cure, especially with the aged. The increase of the number of aged, or industrial workers who are forced to wear air-tight foot-wear, resulted in the increase of tinea pedis/unguium lesions. Undetected tinea pedis patients are problematic since they not only supply the pathogens of tinea unguium but are also a source

of infection for others.

Discovering and treating the hidden tinea pedis patients considering the development of tinea unguium is becoming a public health problem, as well as a private hazard. The control method for tinea pedis as an opportunistic infection should be also be taken under consideration.

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