ORIGINAL ARTICLE

Detection of fungi in other body sites in patients with tinea capitis

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ABSTRACT

Background: Acquisition of dermatophytes can be through external sources or via autoinoculation.

Aim: To study the presence of dermatophytes in other suspected lesions in tinea capitis patients.

Patients and methods: Fifty-five patients with tinea capitis were included. Their ages ranged from 4-62 years (mean ± SD 7.54± 2.16). Hair stumps and scales were collected from the scalp lesion(s). Samples were also collected from suspected lesions in other body sites when applicable. All samples were examined by direct microscopy and culture on Sabouraud's dextrose agar to identify the causative dermatophyte.

Results: From the scalp, direct KOH test and fungal culture were positive in 43 (78.18%) and 38 (69.09%) respectively. Seven dermatophyte species were identified: *Trichophyton rubrum* (12), *T. violaceum* (9), *T. verrucosum* (7), *Microsporum canis* (5), *M. audouinii* (3), *T. tonsurans* (1) and *T. shoenilinii* (1). From lesions outside the scalp, direct KOH test and culture were positive in 11 (20.0%) and 9 (16.36%) respectively. Four dermatophyte species (*T. rubrum, T. violaceum, T. verrucosum* and *Epidermophyton floccosum*) were isolated from lesions affecting trunk, face, upper limb, foot and nails. Three species (*T. rubrum*, *T. violaceum* and *T. verrucosum*) were similarly isolated simultaneously from the scalp and other sites.

Conclusion: The presence of the same dermatophyte simultaneously in more than one site in some tinea capitis patients might indicate auto-infectivity process and explain chronicity and recurrence of infections. A more preventive treatment plan should be advised.

KEY WORDS: Tinea capitis, dermatophytosis, dermatophytes, KOH test, fungal culture

INTRODUCTION

The cutaneous mycoses are among the most common fungal infections worldwide. It is estimated that 10% to 15% of the population will be infected by a dermatophyte at some point in their lives, thus making this a group of diseases with great public health importance.[1] The dermatophytes use keratin to grow; therefore all keratin-containing body parts can become infected.[2]

The dermatophytes comprises 3 genera; Microsporum, Trichophyton, and Epidermophyton.[3] The etiologic agents originate from different sources. Based on host preference and natural habitat, these agents are classified into 3 categories: anthropophilic, zoophilic and geophilic species.[4] The predominance of specific pathogens varies with geography, environments, climates, occupations, ethnic groups and life styles.[5] Transmission of dermatophytes may occur by direct contact with infected humans or animals or indirectly by contact with contaminated fomites.[6]

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The incubation period varies from several days to few weeks, depending on the species and the host.[7]

Tinea infection should be suspected in any red, scaly, pruritic, enlarging lesion or in pruritic scalp lesions that manifest scaling, folliculitis, or an inflammatory reaction.[8] Clinically, tinea capitis is characterized by infection of the hair and skin of the scalp associated with symptoms and signs of inflammation and hair loss.[5] Outbreaks of tinea infections can occur in schools, households and institutional settings through contact with infected humans and animals, soil, or inanimate objects.[8,9] The source of trunk, groin or extremities infections may be clothes, underwear or towels and sponges. Scalp diseases may happen through using the same brushes or combs. Shoes, socks, accessories for feet care or cosmetic pedicure are often the source of infections of feet and toenails.[10] Depending on the species, the organism may be viable in the environment for up to 15 months.[11]

Predominance of certain type of tinea depends on the organism, its hosts, and local factors.[8] The increasing incidence and the continuous changes of the predominant etiological agents of tinea capitis make it necessary for a constant update about this subject.[12] The clinical diagnosis can be unreliable because tinea infections have many mimics, which can manifest identically.[13] The purpose of the present study was to establish the presence and distribution of dermatophytes recovered from suspected hair, skin or nail lesions in patients examined for tinea capitis. This is to verify the possibility that scalp fungi may act as reservoirs for the spread, chronicity and/or recurrence of fungal infection in other body site(s).

PATIENTS AND METHODS

A prospective study included 55 patients with clinically suspected tinea capitis who attended Dermatology Clinic, Al-Hussein University Hospital, Cairo, Egypt during the period from March 2011 to January 2015. The study was approved by the local committee of medical ethics, and written prior informed consent was obtained from every participant. All were subjected to careful history taking, thorough dermatological examination and mycological study. Every case was screened carefully for the presence of other dermatophytosis elsewhere in the body including face, neck, torso, flexures, extremities, palms and soles, and nails.

Clinical diagnosis of tinea capitis along with other forms of tinea was noted on the initial screening. A specimen was taken from any suspicious scalp, body or nail lesion. After cleaning the selected area(s) with alcohol, dull lusterless hair stubs were plucked by sterile forceps and scales were collected from scaly scalp patches. Scales were also collected from the active edge of suspected lesions in other body regions. For nail lesions, optimal specimens were obtained from the sites of invasion and localization of the fungus depending on the type of onychomycosis. All samples were examined by direct microscopy for the presence of fungal elements, and by fungal culture to identify the causative dermatophyte(s).

Direct Microscopy

Specimens were placed on a clean glass slide and a drop of 10%-30% KOH, depending on the nature of the specimen, was added. After 20 -60 minutes, they were examined thoroughly for the presence of fungal elements. The presence of fungal hyphae and/or spores within (endothrix)

and/or around hair shafts (ectothrix) was considered to be a positive test. Also skin/nail samples showing the presence of filamentous, septate, branched hyphae and/or arthrospores were considered positive.

Cultures on Sabouraud's Dextrose Agar (SDA)

A set of specimen was inoculated onto two types of SDA culture media: one with cycloheximide (to suppress the growth of contaminant fungi) and the other without cycloheximide. Chloramphenicol was added to both culture media to prevent bacterial overgrowth. The media were then incubated in a warm, moist environment at 28°C, and examined regularly to detect growth of any fungus. Observation for growth was done every other day for up to 4 weeks after which the media were reported as positive or negative. The fungi were identified by noting their growth rate, colonial morphology, and microscopic structures. Colonial morphology include color, size, texture, and topography. The microscopic structures of fungi usually provide definitive identification. Microscopic features that were looked for are the type, size, shape and arrangement of spores and the size and color of hyphae.

RESULTS

Among the total of 55 patients, 31 were females and 24 were males. Their ages ranged from 4-62 years (mean ± SD 7.54± 2.16). The highest incidence was seen in the age group of 4-11 years. Only 9 patients were aged more than 14 years. The source of infection was undetectable in some cases, and it was traceable in others. The most of cases (30; 54.54%) had history of animal contact including cats, horses and dogs while 11 (20.0%) gave family history of ringworm infections in one or more members at different anatomical sites. Kerion and inflammatory type tinea capitis were seen more among children coming from rural areas.

Clinically; multiple scaly patch type was the commonest variety followed by black dot type and both were seen in children except 2 cases of scaly patch type noticed in adults.

Table 1 Clinical and mycological results of the study patients (n=55)

Item	Description	n=55 (%)
Mycology of scalp lesions	KOH test +ve	43(78.18)
	Culture +ve	38(69.09)
Type of scalp lesions	Scaly patch type	33(60.00)
	Black dot type	13(23.63)
	Kerion	5(9.09)
	Favus	1(1.81)
	Other lesions	3(5.45)
Species isolated from the scalp	*T. rubrum*	12(21.82)
	T. violaceum	9(16.36)
	T. verrucosum	7(12.73)
	M. canis	5(9.09)
	M. audouinii	3(5.45)
	T. tonsurans	1(1.81)
	T. shoenilinii	1(1.81)
Mycology of lesions outside the scalp	KOH test +ve	11(20.00)
	Culture +ve	9(16.36)
Type of lesions outside the scalp	Tinea corporis	5(9.09)
	Tinea faciei	3(5.45)
	Tinea pedis	2(3.64)
	Tinea unguium	1(1.81)
Species isolated from lesions outside the scalp	*T. rubrum*	3(5.45)
	T. violaceum	3(5.45)
	T. verrucosum	2(3.64)
	E. floccosum	1(1.81)

n= number; %= percentage; KOH= potassium hydroxide; +ve= positive; T= trichophyton; M= microsporon; E= epidermophyton.

Table 2 Clinicomycological correlation of 38 isolates from tinea capitis lesions

Isolates	Scaly patch	Black dot	Kerion	Favus	n=38 (%)
T. rubrum	+ (11)	+ (1)	-	-	12 (31.57)
T. violaceum	+ (3)	+ (6)	-	-	9 (23.68)
T. verrucosum	+ (3)	-	+ (4)	-	7 (18.42)
M. canis	+ (4)	-	+ (1)	-	5 (13.15)
M. audouinii	+ (2)	+ (1)	-	-	3 (7.89)
T. tonsurans	-	+ (1)	-	-	1 (2.63)
T. schoenleinii	-	-	-	+ (1)	1 (2.63)
Total	23	9	5	1	38 (100)

n= number; %= percentage; += present; -= absent; T= trichophyton; M= microsporon.

Table 3 Clinicomycological correlation of 9 isolates from non-tinea capitis lesions

Isolates	Tinea corporis	Tinea faciei	Tinea pedis	Tinea unguium	n=9 (%)
T. rubrum	+ (2)	-	-	+ (1)	3 (27.27)
T. violaceum	+ (2)	-	+ (1)	-	3 (27.27)
T. verrucosum	-	+ (2)	-	-	2 (18.18)
E. floccosum	-	-	+ (1)	-	1 (9.09)
Total	4	2	2	1	9 (100)

n = number; % = percentage; + = present; - = absent; T = trichophyton; M = microsporon; E = epidermophyton.

Five cases of kerion (4 children and 1 adult), and 1 case of favus (adult) were also detected. Three cases were presented with atypical scaly follicular lesions. Outside the scalp, 11 (20%) concomitant ringworm infections were detected; 5 tinea corporis, 3 tinea faciei, 2 tinea pedis and 1 tinea unguium (Table 1, Figs. 1 & 2). Tinea capitis preceded these lesions in 5 patients. In 3 cases, tinea capitis followed the body lesions, and in the remaining 3 the lesions were noticed simultaneously.

Mycologically; direct KOH mount and culture were positive in 43 (78.18%) and 38 (69.09%) respectively. All cultures were KOH-positive. From the 38 positive cultures from the scalp, 7 dermatophyte species were identified. Outside the scalp, KOH mount was positive in 11 cases (20%) while cultures were obtained from different sites in 9 cases (16.36%) comprising 4 dermatophyte species (Table 1).

Clinicomycological correlation (Table 2 & 3) showed that scaly patch type was caused by *T. rubrum, T. violaceum, T. verrucosum* (Fig. 3), *M. canis* and *M. audouinii*. Black dot type was caused by *T. violaceum, T. rubrum, T. tonsurans* and *M. audouinii*. Kerion cases were caused by *T. verrucosum* and *M. canis* while the case of favus was caused by *T. shoenilinii*. From outside the scalp; we isolated *T. rubrum, T. violaceum, T. verrucosum*, and *Epidermophyton floccosum* from lesions affecting the trunk, face, upper limb, feet and nails. Cases of tinea unguium and tinea

Fig. 1 Tinea capitis with tinea corporis: Scaly patch type of tinea capitis characterized by marked hair loss with circinate lesion on the dorsum of right hand in the same child (8 years-old boy) caused by *T. rubrum*.

Fig. 2 Tinea capitis with tinea faciei: Scaly patch type of tinea capitis characterized by partial hair loss and marked erythema with circinate inflammatory lesion on the forehead with normal skin in between in the same patient (25 years-old female) caused by *T. verrucosum*.

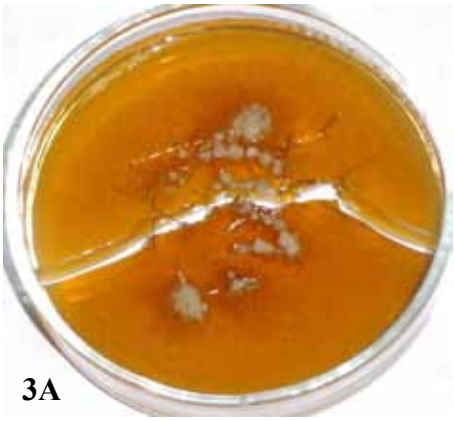

Fig. 3 (a) Macroscopic morphology of *T. verrucosum*: Colonies are small, button-or-disk-shaped, golden-yellow, with a suede-like to velvety surface, a raised center, and flat periphery (from patient in Fig. 2). (b) Microscopic morphology of *T. verrucosum*: Broad irregular hyphae with many terminal and intercalary chlamydospores. Chlamydospores are often in chains. Macro and microconidia are rare (water mount x 200).

pedis occurred exclusively in adult patients.

T. rubrum was the commonest etiological fungus isolated from tinea capitis and non-tinea capitis lesions. It mostly caused scaly patch type tinea capitis and non-inflammatory lesions elsewhere. Inflammatory tinea capitis and kerion were mostly caused by zoophilic *T. verrucosum* and *M. canis,* While, *T. violaceum, T. tonsurans* and *M. audouinii* contributed to non-inflammatory lesions. Three out of the 4 dermatophyte species isolated from lesions outside the scalp were also similarly isolated simultaneously from the scalp in 4 patients. These included *T. rubrum* (1 tinea corporis and 1 tinea unguium), *T. violaceum* (1 tinea corporis) and *T. verrucosum* (1 tinea faciei). The remaining species (*E. floccosum*) was, however, different.

DISCUSSION

Dermatophytosis can affect all keratinized areas of the body (hair, skin, nails). Fungi can be transmitted via direct or indirect contact with skin or scalp lesions of infected people, animals or fomites [i.e. floors, shower stalls, clothing, hairbrushes, etc.[3]] contaminated with desquamated epithelium.[7]

Fungal infectivity is often diverse and heterogeneous, and it is important to be familiar

with the fact that the acquisition of infection may be due to varied outdoor/indoor exposure of individuals to pathogenic fungi. Scalp tinea may result from or contribute to other forms of ringworm infections via autoinoculation. It is possible that carriage of dermatophytes in certain sites such as toe webs, crural area, scalp and even nails may serve as reservoirs for the recurrence or spread of infection; though the infection in these areas may not be clinically apparent. In the present study, out of 55 patients clinically diagnosed as tinea capitis, culture was positive in 38 (69.09 %) patients, while KOH mount was positive in 43 (78.18 %). The isolated fungi were identified as: *T. rubrum* (12), *T. violaceum* (9), *T. verrucosum* (7), *M. canis* (5), *M. audouinii* (3) *T. tonsurans* (1) and *T. shoenilinii* (1).

Clinically, the highest incidence of scalp ringworm was seen in the age group of 4-11 years (mean ± SD 7.04± 1.93). Scaly patch type was the commonest variety (60 %) followed by black dot type (23.63 %) and kerion (9.09%). These findings were comparable with those of Sajjan and Mangalgi[14] who reported that the highest incidence was seen in the age group of 5-10 years (mean ± SD 9.24± 3.07); gray patch (58.8%) was the commonest clinical type followed by black dot (21.5%) and kerion (13.7%). Farooqi et al[15] reported that patients of tinea capitis were presented with gray patch (35.1%), black dot (31.2%) kerion (24.8%) followed by favus (5.0 %). They further documented that 37 (18.2%) had dermatophyte infection elsewhere in the body; 17 (8.4%) of them had tinea faciei, 16 (7.9%) had tinea corporis and the remaining 4 (2%) patients had tinea unguium. Tinea capitis preceded these lesions in 25 (67.5%) patients, and in the remaining 12 (32.5%) followed the body lesions. This is comparable to our results in which 11 concomitant ringworm infections (20%) were detected; 5 tinea corporis (9.09%), 3 tinea faciei (5.45%), 2 tinea pedis (3.64%) and 1 tinea unguium (1.81%). Tinea capitis preceded body lesions in 5 patients (9.09%). In 3 cases (5.45%) tinea capitis followed them, and in the remaining 3 (5.45%) the lesions were noticed simultaneously. The apparent difference could be due to varied number of enrolled patients in both studies (202 versus 55).

In this work, we were able to isolate both anthropophilic (*T. rubrum, T. violaceum, T. schoenleinii, M. audouinii* and *E. floccosum*) and zoophilic (*T. verrucosum* and *M. canis*) fungi from patients living in urban area, which could be explained by the process of immigration and traveling from rural to urban regions and vice versa. Kerion and inflammatory type tinea capitis, caused mostly by zoophilic fungi, were rather seen among children coming from rural areas. Of the 4 dermatophyte species isolated from outside the scalp, only *T. verrucosum* was the zoophilic one. This fungus caused lesions in the scalp and face simultaneously in 2 patients. This means that zoophilic fungi beside its inflammatory nature can produce more than one type of lesions.

In this study, the anthropophilic *T. rubrum* was the predominant etiological agent isolated from tinea capitis and non-tinea capitis lesions. This coincides with the findings of most of the earlier reports.[16-18] This may be attributed to the fact that the lesions caused by anthropophilic fungi are more apt to become chronic and non-inflammatory, a reason that may cause delay in seeking medical help and thereby increasing the chances of fungal transmission. On the

other hand, infection by zoophilic fungi is often associated with an acute inflammatory clinical presentation.

Infection by zoophilic fungi is considered an occupational hazard for humans in rural areas. *M. canis* is the most common agent in Europe, particularly the countries bordering the Mediterranean area.[19] However, there is general agreement that this fungus has worldwide distribution, and does occur in epidemics especially in rural communities. The reported frequency of *T. verrucosum* as a cause of scalp infection is varied. It has been reported as an epidemic in regions[20] and sporadically isolated in others.[19] Ali et al[21] identified 12 growths (13.8%) as *T. verrucosum*. It was reported as a causative agent of tinea capitis (7.8%) for the first time in Benghazi, Libya.[22] The increased isolation of these fungi from our patients may be due to increased exposure to the natural animal reservoirs, and closeness of indoor and outdoor animal to human contact especially to cattle, which is common in Egyptian rural communities. Data concerning the prevalence of these pathogens in Egypt is limited and there are only some sporadic reports. Similar to this work, in another Egyptian study from Ismailia and Port Said Provinces, the anthropophilic species dominated the etiology of human dermatophytosis. The zoophilic species represented nearly one third of the totally obtained isolates, with the most important organisms being *M. canis, T. mentagrophytes* and *T. verrucosum*.[23] Azab et al[24] reported *T. violaceum* (40.3%) and *M. canis* (30.8%), as the most common agents. *T. verrucosum* and *M. audouinii* was isolated only from 3 cases (5.8%) while the *M. canis* was not isolated. In a multicenter clinicomycological study evaluating the spectrum of adult tinea capitis in Egypt, the anthropophilic species outnumbered the zoophilic species. Fungal cultures showed *T. violaceum* in 56.9%, *M. audouinii* in 19%, *M. canis* in 15.5%, and *T. schoenleinii* in 8.6%.[25] The observed differences between these results could be explained by the different study conditions eg, number of patients, geographical and environmental factors as well as socioeconomic standards.

Fungal infection of the skin and its appendages may be acquired in different ways. There is direct and indirect transmission among the triad of humans, animals and environment. Self-infection is caused by transferring fungal spores from one to another part of the same body, mostly by scratching. Direct and indirect infection can also be caused by infected hair fragments, skin squamae, underwear, combs and brushes, hats, bed linen, towels, floor carpets, shower plates, etc. Overcrowding and poor personal hygiene favor the transmission and persistence of the infection especially in hot humid atmospheres like that in Egypt. In this study, the same dermatophyte species were isolated in 4 patients simultaneously from the scalp and lesions outside the scalp at different anatomical locations including face, trunk, foot and toenails. Fungi tend to infect warm and moist areas of skin such as flexures, however, fungi can spread to all keratinous structures like hair and nail. Fingernails have a major role in spread of fungi from itchy infected site to other non-infected areas eg, from the foot to the scalp and vice versa. Scratching infected areas may also spread the fungus to the fingernails themselves. Again, from the nail the fungus can be spread to wherever the person touches, eg, scalp.

But, why the dermatophytes can be transmitted and colonize the skin? Because the skin environment is condusive to dermatophytes, the corneal layer lacks blood vessels making it difficult to contact with immunologically competent cells and activate the defense mechanisms. On the surface of the epidermis are proteins, carbohydrates and micronutrients, which may provide substrates for the metabolism of fungi and help them to survive. Of great importance may also be some specific anatomic regions of the skin, greatly facilitating the colonization by fungi. Scalp hair can therefore arrest arthrospores spreaded by air or nail. Similarly, spores are arrested in the hyponychium under nail or in the interdigital spaces, or in the folds of the skin where additional occlusion helps them to develop.[26] The spores are particularly resistant to environmental conditions, such as variable temperature and drying.[27]

In Egypt, large family sizes, close familial contact and sharing of personal items such as hairbrushes, hats and towels are common. This, in addition to overpopulation, hot humid atmosphere and increased environmental exposure to fungi, may be responsible for the increased prevalence of tinea infections. Dispersal of fungi from patient's scalp, crural or foot lesions to other sites as the trunk and limbs or from sharing of non- personal items can also occur. To minimize fungal infectivity, asymptomatic carriers and hidden clinical lesions should be detected and treated. Transmission should also be prevented by avoiding sharing of non-personal objects, such as hats and hairbrushes.

Supporting the goal of this study, Zhan et al[28] described a 48-year-old female presenting with dandruff and breakable hair for more than 40 years, dry scaly erythema on bilateral palms and feet accompanying with nail destruction for 20 years, and scaling papules on the buttock for 5 years. Mycology workup revealed the cause as *T. violaceum* from all lesions.

CONCLUSION

A variety of dermatophytes from tinea capitis lesions as well as from other sites have been isolated. The existence of the same fungus in more than one site in some patients might explain auto-infectivity process, chronicity and/or recurrence of such infections. This must be kept in mind when treating such lesions. In lesions outside the scalp and nails, it may be necessary to give systemic antifungals in chronic and/or recurrent infections.

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