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Clinicoetiologic investigations on superficial mycoses of Warangal (A.P) India

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PEER REVIEW

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Comments

This is a good study in which the authors systematically analyzed the size and magnitude of dermatophytoses problem in Warangal. The study reveals that superficial mycoses are very common in Warangal. Tinea corporis is the most common clinical manifestation and majority of the infections are caused by *Trichophyton* species.
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ABSTRACT

Objective: To study the clinical manifestations and etiological agents of superficial mycosis and to investigate their relationship in superficial mycosis occurring in Warangal, A.P. India.
Methods: The present study was conducted on 400 clinically diagnosed patients with dermatophytoses. Three different types of samples *viz.* skin scrapings, hair samples and nail clippings were collected for examinations. The samples were processed for microscopic examination, histological study and culturing of etiological agent. The incidence of various dermatophytic species in relation to clinical types was recorded.
Results: Among different clinical types, tinea corporis was most common. The most frequently isolated dermatophytes were *Trichophyton* species which were isolated from all the three samples *i.e.* skin, hair and nail. A majority of the diagnosed patients showed erythematous, scaly annular lesions with raised and inflammatory borders with itching. Mixed infections, which constituted about 3.5%, were a combination of tinea corporis and tinea cruris. Either individually or in mixed infections, these two infections are caused by *Trichophyton* species. Tinea capitis infections which include ectothrix and endothrix are caused by species of *Microsporum* and *Trichophyton*.
Conclusions: The investigations reveal that superficial mycoses are very common in this region. Tinea corporis is the most common clinical manifestation. Majority of the infections are caused by *Trichophyton* species. Mixed infections constituted a small proportion.

KEYWORDS
Dermatophytoses, *Trichophyton*, *Epidermophyton*, *Microsporum*, Mixed infections

1. Introduction

Dermatophytic infections are one of the earliest known fungal infections of mankind and are very common throughout the world. Although rarely life threatening, they can have debilitating effects on a person's quality of life and may in some circumstances spread to other individuals or become invasive. In the developed countries even the most bacterial infections are controlled, the fungal infections have assumed greater importance[1]. Fungal infections are

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extremely common in the tropical region and they produce diverse human infections ranging from superficial skin infections to internal organ invasion (systemic disease). These infections usually occur as a result of decrease in natural human defenses (immunocompromised individuals), or heavy exposure to the fungus[2]. According to site of infection, the fungal diseases are classified into 5 types[3], superficial mycosis, subcutaneous mycosis, systemic mycosis, opportunistic mycosis, and miscellaneous mycosis. The superficial (cutaneous) mycoses are usually confined to the outer layers of skin, hair, and nails, and do not invade living tissues. The fungi causing superficial mycoses are called dermatophytes which are more appropriately, keratinophilic fungi, produce extracellular keratinases, capable of hydrolyzing keratin.

The presumptive diagnosis of fungal infections is based on clinical expressions of the disease. Superficial mycoses often produce characteristic lesions that strongly suggest their fungal etiology of disease. Recently, the clinical importance of fungal infections has been better recognized mainly due to increased awareness among medical personnel. In combination with modern imaging techniques for patients' evaluation, the understanding has improved the accuracy and speed of diagnosis[4]. Nevertheless the diagnosis based on the interpretation of clinical picture may be difficult, because identical clinical manifestations may result from widely different etiological agents and vice versa is also true. Therefore, careful examination of skin lesions supplemented with laboratory diagnosis is essential for reliable diagnosis of superficial mycosis.

The Warangal district in Andhra Pradesh, India is predominantly a rural area with tropical climate. Though the ringworm infections are more prevalent, no systemic study and analysis has been made so far. The present investigations were undertaken to identify the size and magnitude of the dermatophytoses problem in this region and further objectives were to study the correlation between the site of infection and the causative agent, incidence of different clinical types of dermatophytoses, clinical types of mixed tinea infections, ectothrix and endothrix infections of tinea capitis and frequency of occurrence of various species in dermatophytoses.

2. Materials and methods

2.1. Study group

The present study was conducted in Warangal, A.P, India which experiences a hot and humid climate for most part of the year, and it receives moderate to heavy rainfall during the monsoon season. Thus the environmental conditions are conducive for development of superficial mycoses. The present study was conducted on 400 clinically diagnosed patients with dermatophytoses who attended the out patients at Government General Hospital (Mahatma Gandhi Memorial Hospital) in Dermatology and Venereology department during the two-year period: January 2009 to December 2010. Most of the patients belong to low and middle socioeconomic groups coming from Warangal town and surrounding villages of Warangal district. The details of patients with regard to name, age, sex, address, occupation, family history, and socioeconomic background, duration of illness, personal contact at home, work place/school and involvement of more than one sites were collected and recorded. Patients were also enquired regarding the treatment taken for ringworm infections, whether topical or systemic and its duration. After recording the necessary information the patients were made to sit in good light, for detailed clinical examination regarding the number of lesions, types, presence of inflammatory margin *etc*. for presumptive diagnosis of disease. If the outbreak is large a random sample was examined.

2.2. Specimen collection

Depending upon the presumptive diagnosis and for further confirmation, three types of samples were collected from three different infected areas[5,6]. The under mentioned equipment, chemicals and glassware were used to collect the clinical samples[5].

i. 70% ethyl alcohol for thorough disinfection of the skin and nail with sterile cotton before collecting specimens; ii. sterile cotton wool swabs in a sterile glass jar; iii. sterile blunt or sharp scalpel blade for scraping the skin and nails; iv. nail cutter sterilized by flaming to cut the nails; v. sterile forceps to epilate the hair; vi. Bunsen burner or spirit lamp, vii. Woods lamp (The dermatophytic infected hair fluoresce under UV lamp)[7]; viii. inoculation wire (straight or L-shaped) to transfer the material; ix. sterile glossy paper or clean white paper to collect material and x. clean glass slides and cover slips.

2.2.1. Skin scrapings

The scrapings of affected skin which was disinfected with spirit or ethyl alcohol were collected by using a scalpel or blade. The samples were collected from toe cleft by using epilating forceps. Invariably, the material was collected from the definite edge or margin of the lesion.

2.2.2. Hair samples

Infected hair was plucked rather than cut carefully and was taken to choose broken hairs, which lack luster, and were seen to be fluorescent with the Woods lamp. The hairs were epilated with sterile forceps and a part of scalp material was scraped on a sterile glossy paper. This process was proved better to get good hair specimens rather than plucking.

2.2.3. Nail clippings

Nails were sampled by clipping the affected part after disinfecting it with 70% ethyl alcohol. In case of white superficial onychomycosis the dorsal plate was scrapped. In acute infections deeper part of the nail and debris were collected. All the samples were collected on a sterile glossy paper and were preserved in folded slips of black paper except for hair and were stored for further study.

The samples collected from the patients were transported immediately under aseptic conditions, processed appropriately and subjected to different tests at the earliest possible *i.e.*, on the same day. The specimen materials were apportioned into 2-3 parts and used for different tests as described below. The diagnosis of fungal infections of the skin is usually based on the location and characteristics of the lesions and on the following laboratory examinations.

i. Woods lamp[7]. ii. Direct demonstration of fungi in 10% KOH cleared scrapings from suspected lesions. "If it's scaly, scrape it" is a time-honored maxim. iii. Histological sections of biopsies stained with periodic acid-Schiff (Hotchkiss-McManus) technique if scrapings and cultures are negative. iv. Culturing of organisms from skin scrapings and microscopic examination.

3. Results

3.1. Relative incidence of various dermatophytic species

The various clinical types included tinea corporis, tinea cruris, tinea unguium, tinea pedis, tinea capitis, tinea mannum, tinea faciei and mixed infections. A critical analysis revealed that tinea corporis was the commonest clinical type with 37 cases (31.09%) out of a total of 119 culture positive cases reported. Tinea cruris and tinea unguium occupied second and third place with 19 (15.96%) cases and 17 cases (14.28%), respectively. This was followed by tinea pedis and tinea capitis with 15 cases (12.60%) each in fourth position. The fifth position was shared by tinea mannum and mixed infections with 6 cases (5.04%) each. The least incidence was recorded for tinea faciei with 4 cases (3.36%) only.

3.2. Species-wise incidence of dermatophytes

Table 1 reveals the prevalence of dermatophytes in culture positive cases. It is evident that the most frequent dermatophytes isolated were *Trichophyton rubrum* (*T. rubrum*) (33.61%) and *Trichophyton mentagrophytes* (*T. mentagrophytes*) (15.96%), followed by *Trichophyton violaceum* (*T. violaceum*) (12.60%), *Microsporum gypseum* (*M. gypseum*) (10.04%), *Epidermophyton floccosum* (*E. floccosum*) (7.56%), *Microsporum audouinii* (*M. audouinii*) (6.72%), *Trichophyton schoenleinii* (*T. schoenleinii*) (4.20%), *Microsporum canis* (*M. canis*) (4.20%), *Trichophyton tonsurans* (*T. tonsurans*) (3.36%) and *Trichophyton verrucosum* (*T. verrucosum*) (1.68%).

Table 1
Frequency of etiological agents isolated from different clinical samples.

Dermatophytic species	No. of cases	Percentage (%)
T. rubrum	40	33.61
T. mentagrophytes	19	15.96
T. violaceum	15	12.60
M. gypseum	12	10.04
E. floccosum	9	7.56
M. audouinii	8	6.72
T. schoenleinii	5	4.20
M. canis	5	4.20
T. tonsurans	4	3.36
T. verrucosum	2	1.68
Total	119	100.00

3.3. Variations in clinical lesions

The variations in clinical lesions recorded in the present investigations are presented in Figure 1 and Table 2. It is evident from the results that out of a total of 400 clinically diagnosed cases 157 (39.25%) cases showed erythematous, scaly, annular lesions with raised and inflammatory borders with itching. A total of 89 (22.25%) patients showed nonerythematous, non scaly lesions in the form of vesicles and pustules with itching. About 60 (15.00%) cases were reported for erythematous, non scaly lesions without itching. Out of 50 cases, 33 (8.25%) cases were with symptoms with destruction of nail bed and remaining 17 (4.25%) cases showed infection of nail bed with accumulation of debris and pus under the nail. In tinea capitis the lesion formation and infection sites were completely different from other tinea infections as the hairs are involved in the infection. Tinea capitis is an infection to the scalp and shaft of the hairs. The infected hair is dull and grey in colour. There is a breakage of hair at follicular orifice that creates patches of alopecia with black dots of broken hairs. The clinical presentations of tinea capitis vary from a scaly non inflamed dermatitis

resembling seborrheic dermatitis to an inflammatory disease with scaly erythematous lesions. Hair loss or alopecia occurs and may progress to severely inflamed deep abscesses, which is termed as keroin, with the potential for scarring and permanent alopecia. Deep boggy red areas are characterized by severe acute inflammatory lesions with pustule formation resulted in keroins. Favus is another form of tinea capitis chronic infection mostly caused by *T. schoenleinii* and occasionally by *T. violaceum* or *M. gypseum*. Scalp lesions are characterized by the presence of yellow cup-shaped crusts termed scutula, which surround the infected hair follicles. In some cases there are vesicles and pustules on the scalp and a crust around the infected follicles. The type of disease elicited depends on interaction between the host and the etiologic agents. Results presented in Table 2 reveals that out of 400 cases, 44 cases (11%) belonged to tinea capitis infections. Within this patient group of 44, 18 patients (40.90%) showed scalp infection with patches of alopecia, 7 patients (15%) with keroin infection, a painful inflammatory, raised, circumscribed and suppuration. Six patients (13.63%) had vesicles and pustules on the scalp and remaining 4 patients (9.09%) suffered from crusts on the scalp.

3.4. Mixed or multiple infections

Mixed infections are of those with more than one type of infections in the same person. The clinical lesions are manifested on different parts of the body. The data pertaining to this aspect is presented in Table 3. Out of 400 cases, only 14 cases (3.50%) were found to be of mixed infection type. In culture positive cases, out of 119 only 6 cases (5.04%) were mixed type. The critical analysis of Table 3 also reveals that the most common mixed infection was a combination of tinea corporis and tinea cruris with 7 cases (50%) out of 14 total cases followed by tinea capitis and tinea corporis with 4 cases (38.57%). This study indicates that mixed infection

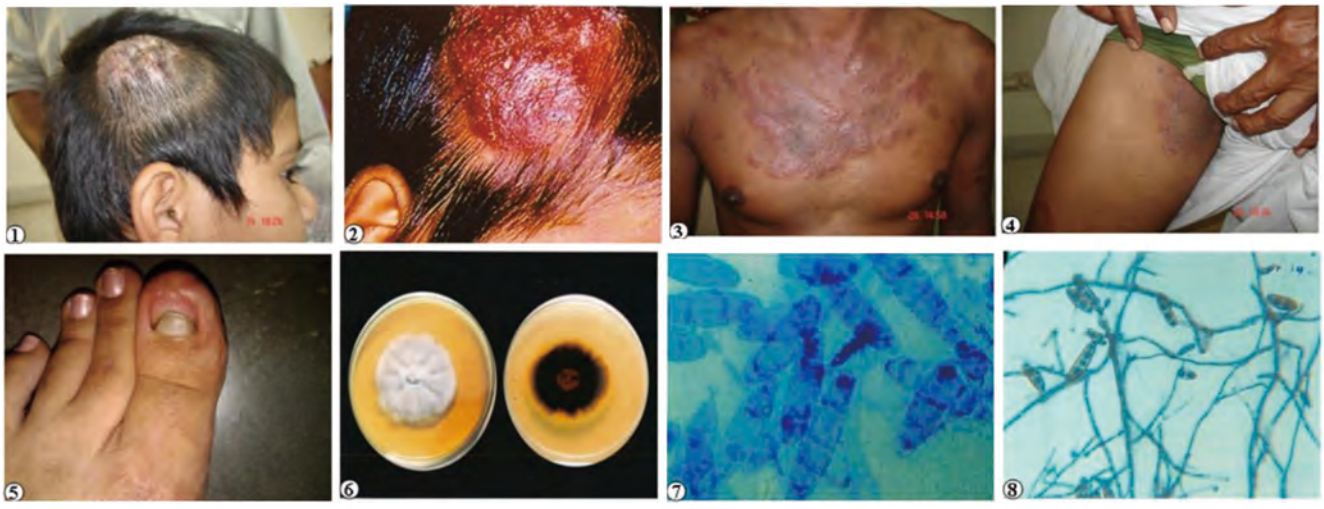

Figure 1. clinical lesions, cultures and photomicrograph of the dermatophytes.
1. Tinea capitis: showing alopecia; 2. Tinea capitis: showing a boggy swelling with pustules in keroin formation; 3. Tinea corporis: showing irregular lesions on the chest of a male patient; 4. Tinea cruris: showing irregular lesions on the groin region of a male patient; 5. Onychomycosis: showing infected and totally destroyed nail whichis rejuvenating slowly after application of antifungal ointments; 6. *T. rubrum* showing fluffy white colored colony on the obverse side and a deep red non-diffusible pigment on the reverse side; 7. Photomicrograph of *M. gypseum* showing characteristic spindle shaped macroconidia under lactophenol blue staining (×400); 8. Photomicrograph of *E. flocossum* showing multicellular club shaped macroconidia under lactophenol staining (×150).

Table 2
Variations in clinical lesions of tinea infections.

Types of clinical lesions	Total No. of cases	Percentage (%)
Erythematous, scaly, annular lesions with raised and inflammatory borders with itching	157	39.25
Nonerythematous, non scaly lesions in the form of vesicles and pustules with itching	89	22.25
Erythematous, non scaly lesions without itching	60	15.00
Tinea unguium-destruction of nail plate	33	8.25
Tinea unguium-infection of nail bed with accumulation of sublingual debris	17	4.25
Tinea capitis-patches of alopecia	18	4.50
Tinea capitis (keroin)-painful, raised, circumscribed, boggy mass with inflammation and suppuration	7	1.75
Tinea capitis-vesicles and pustules	9	2.25
Tinea capitis-black-dot ringworm	6	1.50
Tinea capitis-crusts on scalp	4	1.00
Total	400	100.00

of tinea cruris is usually an extension of tinea corporis. Similarly tinea faciei is also an extended infection of tinea corporis. The tinea unguium was mixed with tinea mannum and that was an example for the extensive spread of the infection. Even other opportunistic fungi like *Aspergillus fumigatus*, *Candida albicans* (*C. albicans*) and *Mucor* spp. were also associated with the tinea infections and similar observations about the presence of non dermatophytic fungi were reported in Nigeria among primary school children[8].

Table 3
Different species of dermatophytes isolated from mixed infections.

Case No.	Clinical isolates	KOH	Culture	Isolated species
18	Tinea capitis and tinea corporis	+ve	−ve	*Aspergillus fumigatus*
27	Tinea corporis and tinea cruris	+ve	−ve	–
39	Tinea pedis and tinea unguinum	+ve	−ve	*C. albicans*
68	Tinea corporis and tinea faciei	−ve	+ve	*T. rubrum*
77	Tinea capitis and tinea coporis	+ve	+ve	*T. rubrum*
133	Tinea corporis and tinea cruris	+ve	+ve	*T. mentagrophytes*
184	Tinea corporis and tinea cruris	+ve	−ve	–
214	Tinea corporis and tinea cruris	+ve	−ve	–
237	Tinea capitis and Tinea corporis	+ve	+ve	*T.verrucosum*
259	Tinea capitis and Tinea corporis	+ve	−ve	*Mucor* spp.
294	Tinea mannum and tinea unguinum	−ve	+ve	*T. violaceum*
322	Tinea corporis and tinea cruris	+ve	−ve	–
358	Tinea corporis and tinea cruris	+ve	−ve	–
391	Tinea corporis and tinea cruris	+ve	+ve	*T. rubrum*

+ve: Positve, −ve: Negative.

In the present study, the clinical isolates obtained from the mixed infections were mainly *Trichophyton* species. *T. rubrum* was seen with 3 cases (50%) out of 6 culture positive cases. There were no isolates of *Microsporum* and *Epidermophyton* species from the mixed or multiple infections. Hence *Trichophyton* species appeared to be the main etiological agents of mixed dermatophytic infections.

3.5. Isolation of different dermatophytic species from different clinical types

Dermatophyte species isolated from various clinical samples in different clinical conditions of tinea infections are presented in Table 4. It is evident that the *T. rubrum*, *T. mentagrophytes* were isolated from all the three types of samples *i.e.*, skin, hair and nail, whereas *M. audouinii*, *M. gypseum*, *T. violaceum* and *T. tonsurans* were isolated from skin and hair samples. *E. floccosum* was isolated from skin and nail samples only. *M. canis*, *T. verrucosum* and *T. schoenleinii* were isolated from skin specimens only. Thus this study reveals that *Trichophyton* species could infect skin, hair and nails. *Microsporum* species could infect skin and hair and *Epidermophyton* species infect skin and nail only.

Table 5 summarizes the different species of dermatophytes isolated and their incidence in different clinical types of tinea. A critical analysis reveals that in tinea corporis, out of 37 culture positive cases the highest prevalence was recorded for *T. rubrum* with 13 cases which was similar to the findings of Pakshir and Hasheme[9], followed by *T. violaceum* with 7 cases. The least incidence was recorded for *T. verrucosum* and *M. gypseum* with one case each. The incidence of *T. mentagrophytes* was in third position with 5 cases and *M. audouinii* and *T. schoenleinii* were in fourth place with 4 cases each. No case was reported for *T. tonsurans* and *M. canis*.

Table 6 summarizes the incidence of different dermatophytic species in tinea cruris infections with culture positive cases. Out of 19 culture positive cases *T. rubrum* showed high incidence with 8 cases followed by *M. gypseum* with 4 cases and *T.mentagrophytes* with 3 cases. Least incidence was recorded with *T. violaceum*, M.audouinii, *T. schoenleinii* and *M. canis* with one case each. No incidence of *E. flocossum*, *T. tonsurans* and *T. verrucosum* was reported.

Tinea capitis, a fungal infection of scalp hair can be caused by any species of either *Trichophyton* or *Microsporum*. Table 7 summarizes the data pertaining to the incidence of dermatophytic species in ectothrix and

Table 4
Species wise incidence of dermatophytes in various clinical samples (culture positive).

Dermatophytic species	Sample from skin	Sample from hair	Sample from nail	Sample from skin+hair	Sample from skin+nail	Sample from hair+nail	Sample from skin+hair+nail	Total	Percentage (%)
T. rubrum	19	2	3	5	4	3	4	40	33.61
T. mentagrophytes	7	2	1	2	3	2	2	19	15.96
T. violaceum	5	3	–	1	1	3	2	15	12.60
M. gypseum	3	3	–	2	–	3	1	12	10.04
E. floccosum	3	–	5	–	1	–	–	9	7.56
M. audouinii	3	3	–	1	–	–	1	8	6.72
T. schoenleinii	2	–	–	2	1	–	–	5	4.20
M. canis	5	–	–	–	–	–	–	5	4.20
T. tonsurans	2	2	–	–	–	–	–	4	3.36
T. verrucosum	2	–	–	–	–	–	–	2	1.68
Total	51	15	9	13	10	11	10	119	100.00

endothrix of hair infections in tinea capitis. Out of 400 cases recorded only 44 cases (11%) were reported as tinea capitis infections. The culture positive cases account for 34.09% (15 cases). A critical analysis of the Table 7 showed that the incidence of *M. gypseum*, *M. auoduinii* and *T. violaceum* are slightly more with 3 cases each (20%) than *T. rubrum*, *T. tonsurans* and *T.mentagrophytes* with 2 cases (13.33%) each. No case was reported with *T. schoenleinii* infection. The ectothrix infections were caused by all the 5 species, *M. gypseum*, *M. auoduinii*, *T. violaceum*, *T. tonsurans* and *T. mentagrophytes* (except by *T. rubrum* and *T. schoenleinii*). The endothrix infections were caused by *T. violaceum* and *T. tonsurans*, whereas the ecto and endothrix infections were caused by *T. rubrum* and *M. auoduinii*. No single case was reported as culture positive with tinea favosa or favus resulting from infection by *T. schoenleinii*.

Table 5
Incidence of dermatophytic species in tinea corporis.

Dermatophytic species	No. of isolates in tinea corporis	Percentage (%)
T. rubrum	13	35.13
T. mentagrophytes	5	13.51
T. violaceum	7	18.91
M. gypseum	1	2.70
E. floccosum	2	5.40
M. audouinii	4	10.81
T. schoenleinii	4	10.81
M. canis	–	–
T. tonsurans	–	–
T. verrucosum	1	2.70
Total	37	100.00

Table 6
Incidence of dermatophytes in tinea cruris.

Dermatophytic species	No. of isolates in tinea cruris	Percentage (%)
T. rubrum	8	42.10
T. mentagrophytes	3	15.78
T. violaceum	1	5.26
M. gypseum	4	21.05
E. floccosum	–	–
M. audouinii	1	5.26
T. schoenleinii	1	5.26
M. canis	1	5.26
T. tonsurans	–	–
T. verrucosum	–	–
Total no. of cases	19	100.00

4. Discussion

Findings of our study with regard to various dermatophytic species are similar to the observations of other investigators. Tinea corporis (25.6%) was the most common ringworm infection followed by tinea cruris (25.0%) in Iran[10]. In Indian context, a number of hospital based studies have also confirmed that a majority of the individuals had tinea corporis infection and the males are more affected than the females[11]. The commonest clinical type seen in our study is tinea corporis (25.6%) followed by tinea cruris (25.0%) which is also corroborated well with other studies[12,13].

Tinea corporis was observed as the commonest clinical type of dermatophytosis followed by tinea pedis, tinea cruris, tinea unguium, in a study report on mycosis at Malappuram district of Kerala[14]. According to the study reports of Kamothi[15], in Rajkote district the commonest clinical type was tinea corporis (41%) followed by tinea cruris (24%). The least incidence was recorded for tinea faciei (3.8%). Our study report corroborate with Falahati *et al.*[16] in Tehran where tinea corporis was the most common form and thereafter in decreasing order of prevalence, tinea unguinum, tinea pedis, tinea mannum and tinaea faciei. Berenji *et al.*[17] reported tinea corporis as the most common form of dermatophytosis and tinea barbae as the least one. A study on superficial fungal infection from West Bengal by Das revealed that half of the study participants were affected by tinea corporis type[18]. Dhara *et al.*[19] also reported that the commonest clinical presentation was tinea corporis (199/377) with overall incidence of 52.78% followed by tinea cruris (59/377, 15.64%).

The study on species wise incidence of dermatophytes revealed that most of the infections in adults are due to *T. rubrum*, which is in agreement with the observations of Dhara *et al*[19]. Other study reports are also corroborating with our findings. According to a study report on epidemiologic surveillance of cutaneous fungal infections in the United States from 1999 to 2002, by Foster *et al.*[20], *T. rubrum* was the commonest infectious agent and is the source of 47% of tinea corporis cases. An Indian study by Dhara *et al.*[19] stated the most common isolate is *T. rubrum* (55.26%) mainly isolated from tinea corporis and tinea cruris

Table 7
Incidence of dermatophytic species in tinea capitis.

Dermatophytic species	No. of isolates in tinea capitis			Percentage (%)
	Ectothrix infections	Endothrix infections	Both ecto– endothrix	
T. rubrum	–	–	2	13.33
M. gypseum	3	–	–	20.00
M. audouinii	2	–	1	20.00
T. violaceum	2	1	–	20.00
T. tonsurans	1	1	–	13.33
T. schoenleinii	–	–	–	–
Total no. of cases	10	2	3	100.00

cases. Balakumar *et al*.[21] stated in his report, among all the pathogens identified *T. rubrum* (32.8%) was the predominant pathogen followed by *T. mentagrophytes* (29.2%). Bose *et al*.[22] reported that the most frequent isolate was *T. rubrum* (33.33%) followed by *T. mentagrophytes* (21.33%). Ranganathan *et al*.[23]reported that *T. rubrum* was the most frequently isolated species (52.2%), followed by *T. mentagrophytes* granular type (zoophilic) (15.59%), *T. mentagrophytes* floccose type (13.76%) and *E. floccosum* (6.11%). In a seven-year survey conducted in Greece[24], *T. rubrum* was reported as the most common dermatophytic fungus. Dhara *et al*.[19] observed that *T. rubrum* was the most common dermatophyte especially dominant in onychomycosis. A study conducted by Venkatesan *et al*.[25] in Chennai, India revealed that *Trichophyton* genus accounted for 93% of dermatophytoses, which was shared by *T. rubrum* (73.3%) and *T. mentagrophytes* (19.7%), followed by *E. floccosum* (4.2%) and *M. gypseum* (2.8%).

Grover *et al*.[26] analyzed 214 patients of tinea capitis in North India and stated that non inflammatory tinea capitis was more common type (56.5%), which is similar with our findings that out of 44 cases, 18 (40%) were with alopecia or non inflammatory type. Our results showed that *Microsporum* spp. and *T. violaceum* are the dominant species isolated from tinea capitis infection. These findings corroborate with the world wide reports. Now *T. tonsurans* is found to be the most common organism in US and Western Europe, whereas in India and Eastern Europe, *T. violaceum* is found to be the most common species. This shift is thought to be due to the widespread use of griseofulvin, which is more effective against *M. audouinii* than *T. tonsurans*; also, changes in immigration patterns and increases in international travel have likely spread *T. tonsurans* to new areas[27]. Usually the incidence was higher in noninflammatory types caused by *T. violaceum* infection than those with inflammatory lesions or keroin, according to the study report on tinea capitis in South Indian by Kamalam and Thambiah[28]. In a study report by Bose *et al*.[29] in the incidence of tinea capitis in a Tertiary Care Rural Hospital the seborrhoeic type was most common clinical presentation (47.36%), followed by the black dot and the keroin type. Fathi and Al-Samarai also found the highest incidence of the seborrhoid type of tinea capitis in their study[30]. Kumar and Lakshmi also reported a higher incidence of tinea capitis of the noninflammatory type[31].

Similar to the present findings on mixed and multiple infections, Poria and Samuel[32], in their study on dermatophytosis in and around Jamnagar reported the incidence of mixed infections to the extent of 6%. Bhaskaran *et al*.[33] in their study on dermatophytosis in Tirupati reported the incidence of mixed infections to be 10.4%. Shokohi *et al*.[34] reported that yeasts were found to be associated with 30% cases of onychomycosis, mainly from fingernails. *C. albicans* and *Candida krusei* were the most prevalent species. In this study, *Candida* species were isolated from a mixed infection of tinea pedis and tinea unguinum.

The predominance of *T. rubrum* in our study report is similar to the findings of Kamothi who studied the prevalence of dermatophytic infections in Rajkote district[15]. According to his findings, *T. rubrum* was the most common species isolated. Tinea corporis was the most common clinical presentation and *T. rubrum* was the predominant fungus. Sivakumar *et al*.[14] revealed that the frequently isolated fungi was *T. rubrum* (in 2 cases), followed by *T. mentogrophytes* (in 18 cases), *E. floccosum* (in 3 cases), *M. mannum* (in one case), and *T. violaceum* (in one case). Venkatesan *et al*.[25] revealed that *T. rubrum* was the predominant species responsible for the dermatophytoses, especially tinea corporis infections, followed by *T. mentagrophytes* (18.3%) and *M. gypseum* (1.4%).

Our observations on the incidence of different dermatophytic species in tinea cruris are similar to Venkatesan *et al*.[25] who reported the predominance of *T. rubrum* in Chennai. Further tinea cruris was the second predominant infection observed (26.8%). *T. rubrum* (22.6%) was the predominant etiological agent isolated from tinea cruris patients followed by *E. floccosum* (2.8%) and *M. gypseum* (1.4%). According to a study report on clinicomycological study of dermatophytosis by Peerapur *et al*.[35] in overall dermatophytic infections, *T. rubrum* (28, 43.7%) was the most frequent isolate followed by *T. mentagrophytes* (18, 28.1%), *E. floccosum* (5, 7.8%) and *Microsporum* (4, 6.2%). In tinea cruris, *T. rubrum* with 8 cases and *T. mentagrophytes* with one case were reported in their study.

Our present observations on incidence of dermatophytic species with hair infections of tinea captis are almost similar to other study reports with slight variations. Nnoruka *et al*.[36] studied patchy hair loss in school children with regard to tinea capitis infection and reported the most common isolated dermatophytes included *M. audouinii* (31.1%), which was associated with patchy scaly tinea capitis than *T. tonsurans* (13.2%). A study report by Singal *et al*.[37] on clinico-myocological profile of tinea capitis in North India and response to griseofulvin stated that *T. violaceum* was the commonest dermatophytic species isolated in 38% patients. *M. audouinii*, *T. schoenleinii*, *T. tonsurans*, *M. gypseum*, *T. verrucosum* and *T. mentagrophytes* were isolated in 34%, 10%, 9%, 3%, 3% and 3% of patients respectively. Kamalam and Thambiah in their investigations on tinea capitis in South Indian families observed that the commonest agent involved was *T. violaceum* (68.6%)[28]. Even Grover *et al*.[26] in their report on tinea capitis in pediatric population reported the same. The other species were *T. tonsurans* (21.6%), *T. rubrum* (6%) and *Trichophyton simii* (3.8%). These findings also revealed that tinea capitis and/or *T. violaceum* infection are endemic in Madras, South India. A recent report by Bose

et al.[29] on the incidence of tinea capitis in a Tertiary Care Rural Hospital at Ahmednagar showed that the commonest isolate was *T. mentagrophytes* (9, 47.36%) followed by *M. gypseum* (5, 26.31%), *M. canis* (3, 15.78%) and *T. rubrum* (5, 26.31%). Geophilic fungi such as *M. gypseum* are usually transmitted from a soil source and can be secondarily transmitted by animals to humans[38]. In the present study 3 patients reported with *M. gypseum* infections were farmers and labourers working in the soil. *T. mentagrophytes* infections were mostly to the patients who were associated with dogs and cattle as it is a zoophilic dermatophyte. *T. violaceum* is one of the commonest isolates from patients with tinea capitis, which has been reported by various workers from India and other parts of the world[39].

Conflict of interest statement

We declare that we have no conflict of interest.

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Comments

Background

Dermatophytic infections are caused by fungi and are common disorders seen mainly in the tropical regions world-wide. These infections cause a spectrum of diseases that can range from superficial skin infections to invasive infections. The superficial/cutaneous mycoses are confined to the outer layers of skin, hair and nails and the fungi causing superficial mycoses are called dermatophytes. Reliable diagnosis of superficial mycoses requires careful examination of skin lesions along with laboratory diagnosis.

Research frontiers

The present study was undertaken on 400 clinically diagnosed patients with dermatophytoses from Warangal, AP, India. Three different clinical specimens (skin, hair and nail) were collected for microscopic examination, histological study and culturing of etiological agent. The incidence of various dermatophytic fungi in relation to clinical types was recorded.

Related reports

Consistent with the present study, Sepahvand *et al.* found that tinea corporis was the most common ringworm infection prevalent in Iran. Similar observations were also found from studies conducted in India and Tehran. With regards to the incidence of dermatophytic species, the present study is very similar to previous reports with only slight variations.

Innovations & breakthroughs

Although ringworm infections are very common in Warangal district, AP, India, no study has been previously done to assess the prevalence of the disease. This is the first report that systematically analyzed the size and magnitude of dermatophytoses problem in this region. The study found that tinea corporis is the most common clinical manifestation and majority of the infections are caused by *Trichophyton* species. The study also demonstrated that a proper diagnosis of dermatophytoses should include careful examinations of the skin lesions along with laboratory diagnosis.

Applications

It may be significant to understand the distribution and nature of dermatophytoses problem in tropical areas such as Warangal, where the incidence rate of this disease is very high. The results of the present study may help the clinicians and health care providers in the differential diagnosis of this disease.

Peer review

This is a good study in which the authors systematically analyzed the size and magnitude of dermatophytoses problem in Warangal. The study reveals that superficial mycoses are very common in Warangal. Tinea corporis is the most common clinical manifestation and majority of the infections are caused by *Trichophyton* species.

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