DERMATOPHYTES, THE CAUSAL ORGANISMS OF DERMATOMYCOSIS: AN OVERVIEW

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Abstract

Dermatophytes are the group of fungi which causes superficial fungal infections in human beings and animal through out the world. They are closely related group of keratinophilic fungi that can invade keratinized tissues of humans and animals such as skin, nails and hairs and have the ability to utilize a unique enzyme that is keratinase. Worldwide millions of people are affected by these fungal infections. Dermatophytes are responsible for most superficial fungal infections. Superficial fungal infections are very common in children. Three most common genera of dermatophytes which belong to class Hyphomyctetes of Deutromycota (imperfect fungi, are *Tricho phyton, Epidermophyton* and *Microsporum*. Fungal diseases are predominant in tropical and subtropical countries, especially in tropical countries like Pakistan and India due to the hot and humid climate.

Introduction

Dermatophytes, a closely related group of keratinophilic fungi that have the ability to invade keratinized tissues of humans and animals such as hairs, skin and nails and can causing dermatomycoses. They are important etiological agents of superficial fungal infections and skin diseases. Mllions of people are affected by them through out the world. Healthy and immunocompromised patients, in both these infections occur and causative agents are fungi and yeasts. For most superficial fungal infections dermatophytes are responsible and a dermatophyte infection obtain the rough calculation lifetime risk is between 10 to 20% (Garg *et al* 2009).

Usually dermatophytes grow between 0°C to 30°C. However some thermophilic fungi like *Thermomyces lanuginosus* grow at 30 to 60°C (Cooney & Emerson, 1964), with an optimum temperature of 45 to 50°C (Qureshi *et al*., 1980). Variation in temperature and humidity causes the fungus to move towards periphery, thus forming a concentric ring. The name "ring worm" to the disease is given for this reason. The centre of the ring contains dead cells that made by oozing secretions, whereas the peripheral zone contains active fungal cells. The virulence of the infecting strains or species, the anatomical location of the infected site and local environmental factor determine the severity of infection (Soltys, 1963). Human fungal diseases are an accidental phenomenon (Rippon, 1985). No race in any geographical location is totally free from dermatophytoses (Rippon, 1988).

Generally dermatophytes are unable to penetrate deeper tissues probably due to inhibition of fungal keratinases and non specific inhibitory factor present in the serum of the host, but occasionally subcutaneous tissues are invaded producing extensive lesions (Sellers *et al*., 1956). The transmission and development of dermatophytic infection is influenced by various factors including, host preference, host's susceptibility, natural habitat of fungi, virulence of infecting pathogen, nutritional status and local environmental factors (Gentles, 1968).

Classification

Dermatophytes belong to class Hyphomycetes of Deuteromycota, bearing conidia on separate conidiophore. Generally they contain three genera:
Trichophyton: - Causes disease hair, skin and nail
Microsporum: - Causes disease hair and skin but not nail
Epidermophyton: - Causes disease nail and skin but not hair
Certain other genera including *Paecilomyces*, *Thermomyces* and *Candida* also cause dermatophytic diseases.
Dermatophytes also classified on the basis of their host preference and natural habitats, into three broad epidemiological groups namely:
Anthropophilic: causing disease in human,
Geophilic: generally inhibit the soil and attacks both animals and human beings
Zoophilic: **c**ausing disease in animals.

Geographical Distribution: In geographical distribution dermatophytes such as *Trichophyton. Microsporum* and *Epidermophyton* are cosmopolitan. In these three genera *Trichophyton* has predominant causes than *Microsporum* and *Epidermophyton*. However in the genus *Trichopthyton*, *T. rubrum* is the predominant causative agent than *T. mentagrophytes*, *T. verrucosum* and *T. tonsurans*. According to the survey of the World Health Organization (WHO) on the prevalence of dermatophytic infection, about 20% present people have cutaneous infections worldwide. *Tinea corporis* is the most common fungal disease (about 70%) than *Tinea* as compared to *T.cruris, T. pedis* and *Onychomycoses*. Nor any race neither people of any age free from dermatophytic infections.

Pathogenesis: Through scars, wounds, injured skin and burns, dermatophytes can enter into the host body. Pathogens, they have the ability to use keratin as a nutrient source so they invade non-living, upmost and keratinized layer of skin that is stratum corneum and produce enzyme namely keratinase. At the site of infection they cause inflammatory reaction and redness, swelling, heat or burning and alopecia are the signs of inflammatory reaction which are seen at the site of infection. The pathogens stir away from the site of infection due to inflammation and produce the ringed lesion. On the basis of disease and affecting organs pathogens are referred to as:

Table 1. Fungal pathogens, diseases and affecting organs

Fungal Pathogen	Disease	Affecting Organs
Trichophyton erinacei	Ring-worm disease	Facial hair
T. violaceum	Black-dot	Nails
T. mannum	Ring-worm disease	Hand and palms area
T. tonsurans	Ring-worm disease	Scalps
T. rubrum	Rock itch	Groin area
T. spp.	Onychomycosis	Finger and toe nails
Microsporum gypseum	Tinea barbae	Face
M. Calais	Ring-worm disease	Arm, legs and trunk
Epidermophyton floccosum	Athlete's foot	Feet
E. floccosum	Tinea ungium	Nails
Cladiosporum carionii	Chromoblastomycosis	Hand, face, ear, neck and chest
Blastomyces dermatidis	Gilchrist's disease	Skin, lungs
Madurella spp.	Madura foot	Feet, hands
Hormodendrum spp.	Deep mycoses	Subcutaneous tissues

Table 2. Worldwide Distribution of Dermatophytes

Clinical Manifestation	Organism	Geographical Distribution
Tinea barbae (Beard)	*Microsporum canis*	North America, some areas of Europe
	Trichophyton megninii	Spain, Portugal, Sardinia
	T. mentagrophytes	Worldwide
	T. rubrum	Worldwide
	T. verrucosum	Worldwide
	T. violaceum	North Africa, East Africa, Middle East
Tinea Capitis (Scalp & Hair)	*Microsporum audouinii*	Eastern Europe, rare in North America
	M. canis	North America, some areas of Europe
	M. ferrugineum	Africa, India, China, Japan
	M. gypseum	Worldwide
	M. nanum	Worldwide
	M. persicolor	Worldwide
	T. megninii	Spain, Portugal, Sardinia
	T. mentagrophytes	Spain, Portugal, Sardinia
	T. schoenleinii	Europe, Asia, Africa
	T. soudanense	Africa
	T. tonsurans	Worldwide
	T. verrucosum	Worldwide
	T. violaceum	North Africa, East Africa, Middle East
Tinea corporis	*Epidermophyton floccosum*	Worldwide
(Glabrous skin)	*Microsporum audouinii*	Eastern Europe, rare in North America
	M. canis	North America, some areas of Europe
	M. gypseum	Worldwide

Clinical Manifestation	Organism	Geographical Distribution
	M. nanum	Worldwide
	M. persicolor	Worldwide
	Trichophyton equinum	Worldwide
	T. mentagrophytes	Worldwide
	T. raubitschekii	Asia, Africa, Middle East, North America
	T. rubrum	Worldwide
	T. schoenleinii	Europe, Asia, Africa
	T. tonsurans	Worldwide
	T. verrucosum	Worldwide
	T. violaceum	North Africa, East Africa, Middle East
Tinea cruris (Groin)	*Epidermophyton floccosum*	Worldwide
	Microsporum nanum	Worldwide
	Trichophyton mentagrophytes	Worldwide
	T. raubitschekii	Asia, Africa, Middle East, North America
	T. rubrum	Worldwide
Tinea manuum (Hand)	*Epidermophyton floccosum*	Worldwide
	Microsporum canis	North America, some areas of Europe
	Microsporum gypseum	Worldwide
	Trichophyton mentagrophytes	Worldwide
	T. rubrum	Worldwide
	T. verrucosum	Worldwide
Tinea pedis (Feet)	*Epidermophyton floccosum*	Worldwide
	Microsporum persicolor	Worldwide
	Trichophyton mentagrophytes	Worldwide
	T. raubitschekii	Asia, Africa, Middle East, North America
	T. rubrum	Worldwide
	T. violaceum	North Africa, East Africa, Middle East
Tinea unguium (Nails)	*Epidermophyton floccosum*	Worldwide
	Trichophyton mentagrophytes	Worldwide
	T. rubrum	Worldwide
	T. tonsurans	Worldwide
	T. violaceum	North Africa, East Africa, Middle East

In Pakistan: In Pakistan no extensive work is carried out on dermatophytic diseases, in human (Abbas & Ghaffar, 1992; Ahmed *et al*., 1997). However, some work has been done at Karachi (Ahmed *et al*., 2006; Ali *et al*., 2006; Anis *et al*., 1988; Ansari & Siddiqui, 2006; Dilnawaz & Naseer, 2001; Farheen & Siddiqui, 2003; Farooqi *et al*., 1981, 1982a, 1982b, 1982c, 1983, 1984a, 1984b, 1987; Haroon, 1985; Khan & Anwar, 1968a, 1968b, 1969; Khan & Hafiz , 1979; Khan & Sheikh 1981; Raza *et al*., 2009; Sabir *et al*., 2003, 2004 & Thebo *et al*., 2006), at Quetta (Malik *et al*., 2009), at Lahore (Ahsan *et al.,* 2010; Aman *et al*., 2001a, 2001b, 2002; Bokhari *et al*., 1999; Hussain *et al.,* 1994; Jahangir *et al*., 1999; Qazi & Sikander, 2005 & Saeed *et al.*, 2009), at Chitral (Haroon *et al*., 1987), at Jamshoro (Thebo *et al*., 2006), at Peshawar (Rasheed *et al*., 2004) and at Rawalpindi (Mirza *et al.*, 2007), at Faisalabad (Abbas *et al*., 2009a, 2009b).

In Karachi, skin infections are very common. These diseases are more common in children as compare to adult. Fungal infections are dominated among these infections. (Yasmeen & Khan, 2005).

Table 3. Distribution of Dermatophytes in Pakistan

Clinical Manifestation	Organism	Reported by
Tinea barbae (Beard)	*Trichophyton. mentagrophytes*	Thebo *et al.*, 2006
	T. rubrum	Thebo *et al.*, 2006
	T. verrucosum	Thebo *et al.*, 2006
Tinea Capitis (Scalp & Hair)	*Microsporum audouinii*	Thebo *et al.*, 2006
	M. canis	Aman *et al.*, 2002
	M. gypseum	Thebo *et al.*, 2006
	Trichophyton. mentagrophytes	Jahangir *et al.*, 1999, Qazi and Sikander,2005
	T.rubrum	Qazi and Sikander,2005
	T.gallinae	Farooqi *et al.*, 1984
	T. tonsurans	Jahangir *et al.*, 1999
	T. verrucosum	Jahangir *et al.*, 1999, Qazi Sikander,2005, Thebo *et al.*, 2006,
	T. violaceum	Hussain *et al.*, 1994, Jahangir *et al.*, 1999, Aman et al., 2002, Ahmed *et al.*, 2006
	T.vanbrenseghamii	Hussain *et al.*, 1994, Jahangir *et al.*, 1999
	Epidermophyton floccosum	Hussain *et al.*, 1994
Tinea corporis (Glabrous skin)	*Microsporum gypseum*	Thebo *et al.*, 2006
	Trichophyton. mentagrophytes	Ansari and Siddiqui, 2006, Sabir *et al.*, 2003, Thebo *et al.*, 2006
	T. rubrum	Ansari and Siddiqui, 2006, Sabir *et al.*, 2003, Thebo *et al.*, 2006
Tinea cruris (Groin)	*Epidermophyton floccosum*	Thebo *et al.*, 2006
	Trichophyton mentagrophytes	Ansari and Siddiqui, 2006, Thebo *et al.*, 2006
	T. tonsurans	Khan and Hafiz, 1979, Sabir *et al.*, 2004
Tinea pedis (Feet)	*Epidermophyton floccosum*	Dilnawaz & Naseer, 2001, Thebo *et al.*, 2006
	Trichophyton mentagrophytes	Ansari and Siddiqui,2006, Dilnawaz & Naseer, 2001, Thebo *et al.*, 2006
	T. rubrum	Ansari and Siddiqui, 2006, Dilnawaz & Naseer, 2001, Rashid *et al.*, 2004, Thebo *et al.*, 2006
	T.vanbrenseghamii	Khan and Hafiz, 1979, Rashid *et al.*, 2004
Tinea unguium (Nails)	*Epidermophyton floccosum*	Thebo *et al.*, 2006
	Trichophyton rubrum	Aman *et al.*, 2001, Ansari and Siddiqui, 2006, Thebo *et al.*, 2006
Onychomycosis	*T. rubrum*	Bokhari *et al.*, 1999

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