Prevalence of Non-dermatophyte Fungi in Interdigital Tinea Pedis

Thesis

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INTRODUCTION

Most of the time, the human species live in peaceful coexistence with the microorganisms that surround them and only when the defense system is damaged or the concentration of pathogens reach an exceptionally high density, an infection may emerge ***(Wisplinghoff et al., ٢٠٠٣).***

Fungi are native inhabitants of soil and water and some species behave as opportunistic pathogens in man. They are ubiquitous and no geographical area or any group of people is spared by these organisms ***(Arvanbitidou et al., ١٩٩٩).*** The sources of water supply are usually contaminated by microorganisms ***(Orji et al., ٢٠٠٦).***

Fungi are eukaryotic organisms characterized by cell wall formed from chitin. They may produce harmful effects since some of them are pathogenic for man, animals, and plants and the toxins produced by some of them (mycotoxins) cause many serious public health problems ***(Taha, ٢٠١١).***

The fungi represent a heterogeneous assemblage of eukaryotic microorganisms ***(Esser et al., ١٩٩٤).*** Only a few of the fungi pathogenic for humans are sufficiently virulent to infect a healthy host. Most are relative harmless unless they encounter an immunocompromised patient, in whom a

weakened defence system permits them to invade the body ***(De Pauw, ٢٠١١).***

Superficial fungal infections of the skin are among the most common diseases seen in our daily practice. These infections affect the outer layers of the skin, the nails and hairs ***(King – man and Tin – sik Cheng, ٢٠١٠).***

Superficial fungal infections are the most common human fungal infections, and ٢٠–٢٥٪ of the world's population has skin mycoses ***(Havlickova et al., ٢٠٠٨).***

Superficial fungal infections of the skin and its appendages can be caused by dermatophytes, yeasts and nondermatophytes ***(Winn et al., ٢٠٠٦; Zarrin et al., ٢٠١٠).*** The yeasts and moulds now rank amongst the ١٠ most frequently isolated pathogens among patients in Intensive Care Units ***(Wisplinghoff et al., ٢٠٠٣).***

Cutaneous fungal infections are common in Tehran, Iran, and causative organisms include dermatophytes, yeasts and non-dermatophyte moulds. The prevalence of superficial mycosis infections has risen to such a level that skin mycoses now affect more than ٢٠-٢٥٪ of the world's population, making them the most frequent form of infection ***(Jahromi and Khaksari, ٢٠٠٩).***

AIM OF THE WORK

The aim of this thesis was to determine the prevalence of non dermatophytic fungi in interdigital tinea pedis.

CUTANEOUS FUNGAL INFECTION

Introduction

Naturally the human species live in peaceful coexistence with the microorganisms that surround them and only when the defense system is damaged or the concentration of pathogens reaches an exceptionally high density, an infection may emerge ***(Wisplinghoff et al., ٢٠٠٣).***

Fungi are native inhabitants of soil and water and some species behave as opportunistic pathogens in man. They are ubiquitous and no geographical area or any group of people is spared by these organisms ***(Arvanbitidou et al., ١٩٩٩).*** The sources of water supply are usually contaminated by microorganisms ***(Orji et al., ٢٠٠٦).***

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The fungi represent a heterogeneous assemblage of eukaryotic microorganisms ***(Esser et al., ١٩٩٤).*** Only a few of the fungi pathogenic for humans are sufficiently virulent to infect a healthy host. Most of them are harmless unless they

encounter an immune-compromised patient, in whom a weakened defense system permits them to invade the body ***(De Pauw, ٢٠١١).***

Superficial fungal infections of the skin are among the most common diseases seen in our daily practice. These infections affect the outer layers of the skin, the nails and hairs ***(King-man and Tin-sik, ٢٠١٠).***

Superficial fungal infections are the most common human fungal infections, and ٢٠–٢٥٪ of the world's population has skin mycoses ***(Havlickova et al., ٢٠٠٨).***

Superficial fungal infections of the skin and its appendages can be caused by dermatophytes, yeasts and non-dermatophytes ***(Winn et al,. ٢٠٠٦ and Zarrin et al., ٢٠١٠).*** The yeasts and moulds now rank amongst the ١٠ most frequently isolated pathogens among patients in Intensive Care Units ***(Wisplinghoff et al., ٢٠٠٣).***

Identification

Fungi, like all living things, are recognized and identified on the basis of their shapes, structures and their behavioral properties. Fungi that exist predominantly in the form of independent single cells are usually called *yeasts* while those based on hyphal threads are called *moulds* (i.e. hyphal fungi).

Hyphae and yeast are nearly always microscopic cell forms. A complex of hyphal strands, hyphal branches and any associated spore-bearing structure is known as a *mycelium* ***(Odds, ١٩٩٦).***

Pathophysiology of Fungal Infections

Under normal circumstances, the intact epithelial surfaces of the gastrointestinal tract will prohibit invasion by micro-organisms and the mucociliary barrier of the respiratory tract prevents aspiration of fungal cells and spores. In contrast, dead or damaged tissue may turn into a breeding ground for infection. For these reasons invasive fungal infections have to be ranked amongst the typically opportunistic infections ***(De Pauw, ٢٠١١).***

The dermatophyte functioning as the inciting agent in these infections is responsible for the destruction of the normal barrier role of the stratum corneum ***(Odom, ١٩٩٣).*** Under appropriate environmental circumstances such as occlusion and humidity, local conditions favor overgrowth of opportunistic bacteria at the expense of the dermatophyte ***(Kates et al., ١٩٩٠).***

Direct inoculation through breaks in the skin occurs more often in persons with depressed cell-mediated immunity. Once fungi enter the skin, they germinate and invade the superficial skin layers ***(Hainer, ٢٠٠٣).***

Dermatomycosis

Dermatomycosis refers to any type of fungal infection involving the skin, while the term disseminated mycosis describes a fungal infection that spreads to involve at least two deep organs and/or the skin ***(Odds, ١٩٩٦).***

Dermatophytoses

Dermatophytoses involve closely related fungi that do not penetrate beyond the outer layers of the skin. The clinical presentation of dermatophyte infections depends on the site of infection, the fungal species, and the host response. Because dermatophytes utilize keratin as a nutrient, they infect areas of the body with abundant keratin: the stratum corneum, hairs, and nails. Traditionally, infections caused by dermatophytes have been named according to their anatomical sites: tinea corporis, tinea cruris, tinea barbae, tinea mannum, tinea pedis, tinea capitis, and tinea unguium. A single dermatophyte species may infect several anatomical locations, and different species may produce clinically identical lesions ***(Raza, ٢٠٠١).***

Dermatophytes are keratinophilic parasites that produce a variety of proteolytic enzymes e.g. keratinases, they can invade the superficial keratin of the skin, and the infection remains limited to this layer. ***(Bristow and Spruce, ٢٠٠٩).***

The dermatophytes that usually cause only superficial infections of the skin are grouped into three genera: Microsporum, Trichophyton, and Epidermophyton ***(King-man and Tin–sik, ٢٠١٠).***

The reasons for superficial mycosis are dermatophyte, yeast and nondermatophyte filamentous fungi. Yeast and non-dermatophyte filamentous fungi are resistant to antifungal medicines and the identification of their types are very important for infection control and public health ***(Evangeline et al., ٢٠٠٥ and Ungpakorn, ٢٠٠٥).***

Transmission

Some dermatophytes are spread directly from one person to another (anthropophilic organisms) which are responsible for most fungal skin infections. Transmission can occur by direct contact or from exposure to desquamated cells. Others are transmitted to humans from soil (geophilic organisms), and still others spread to humans from animal hosts (zoophilic organisms). Transmission of dermatophytes also can occur

indirectly from fomites (e.g upholstery, hairbrushes, and hats) ***(Hainer, ٢٠٠٣).***

Ten species of dermatophytes are commonly isolated, and an additional ٢٠ species are cultured occasionally. The most common dermatophytes causing disease in humans worldwide are listed in table (١).

Table (١): Dermatophytes isolated around the world ***(Bolognia, ٢٠٠٨):***

		Thallus (macroscopic) appearance[*]and/or microscopic findings
Most common		
Trichophyton	*Mentagrophytes* var. mentagrophytes	Granular front, buff reverse; pencil-shaped macroconidia, clusters of round microconidia, spiral hyphae
	Mentagrophytes var. interdigitale	Downy front, buff reverse; see above
	Rubrum	White wooly front, venous blood reverse; pencil-shaped macroconidia, teardrop-shaped microconidia
	Tonsurans	Granular front, mahogany reverse; pencil-shaped macroconidia, microconidia of varying sizes
	Verrucosum	Convoluted, cream to gray, compact; chains of chlamydospores at
	Violaceum	Creamy, waxy, becomes violet
Microsporum	*Canis*	White wooly front, orange reverse; multi-celled, spindle-shaped macroconidia with thick walls and rough surface
	Ferrugineum	Folded red–orange (rust-colored) front
	Gypseum	Cinnamon–tan granular front; multi-celled, cucumber-shaped macroconidia with thin walls
Epidermophyton	*Floccosum*	Khaki green, suede to granular; beaver tail-shaped macroconidia; no microconidia

Table (١): Continued:

		Thallus (macroscopic) appearance[*]and/or microscopic findings
Less common		
Trichophyton	Ajelloi	Powdery surface, resembles *Microsporum* spp.
	Concentricum	Glabrous colonies; antler hyphae
	Equinum	Club-shaped macroconidia
	Gourvilii	Waxy, pink to red front
	Megninii	Pink, felt-like front with red reverse
	Schoenleinii	Glabrous; antler and nailhead hyphae; rat-tail macroconidia (media often fissured)
	Simii	Club-shaped macroconidia in clusters
	Soudanense	Yellow to apricot front with fringed border
	Terrestre	Cream to yellow granular surface
	Yaoundei	Glabrous, chocolate-brown front
Microsporum	*Amazonicum*	Multi-celled, spindle-shaped, macroconidia with large inclusions
	Audouinii	Flat, tan front with salmon reverse; pectinate (comb-like) hyphae
	Cookie	Oval, thick-walled macroconidia
	Equinum	One- to four-celled macroconidia rese mbling *M. canis*
	Fulvum	Bullet-shaped macroconidia with spiral hyphae
	Gallinae	Diffusable pink-red pigment
	Nanum	Two-celled macroconidia
	Persicolor	Pink to red front and reverse, resembles T. mentagrophytes
	Praecox	Powdery front with yellow-orange reverse
	Racemosum	Cream-colored powdery front
	Vanbreuseghemii	Largest macroconidia

TINEA PEDIS

In naming clinical infections due to dermatophytes, 'tinea' precedes the Latin name for the involved body site, e.g. 'tinea pedis' refer to a dermatophyte infection of the foot. Tinea pedis, commonly known as athlete's foot, is a fungal infection of the interdigital toe-web space as well as the skin of the feet. It is the most frequent dermatophytosis ***(Bonifaz and Saul, ٢٠٠٢).***

Tinea pedis is the infection of the feet or the toes with dermatophyte fungi, but infection of the dorsal aspect of the foot is considered tinea corporis ***(Caputo et al., ٢٠٠١)***. Tinea pedis is considered to be the most common fungal infection in the world (approximately ١٠٪ of the total population may have dermatophyte infection of the toe clefts) and also it has been estimated to be the second most common skin disease in the United States following acne vulgaris ***(Weinstein and Berman, ٢٠٠٢).***

Three species of fungi, *Trichophyton rubrum(T.rubrum), Trichophyton mentagrophytes (T.mentagrophytes)* and *Epidermophyton floccosum (E.floccosum)* are together responsible for the majority of cases of tinea pedis throughout the world. Of these keratinophilic organisms, *T. rubrum* is the

most common pathogen associated with chronic tinea pedis ***(Al Hasan et al., ٢٠٠٤).***

Infections that closely resemble those caused by the dermatophytes can be caused by nondermatophyte saprophytic moulds found in soil, air, water, and on fomites ***(Elewski and Greer ١٩٩١).*** These saprophytic moulds can also coexist with the dermatophytes and both can be pathogenic ***(Masri and Fridling, ١٩٩٦).***

Nondermatophyte pathogens that produce clinical findings identical to tinea pedis include: *Hendersonula toruloidea, Scytalidium hyalinum, Scytalidium dimidiatum* (moccasin and interdigital types) and occasionally, Candida species (interdigital type) ***(Summerbell et al., ١٩٨٩).***

Clinical Presentations

The host response to proliferation of the fungus is to increase growth of the basal cell layer of the epidermis, resulting in scaling and thickening of the skin ***(Odom, ١٩٩٣).*** Initially large colony diphtheroids proliferate but increasing severity leads to a dominance of gram-negative organisms. Without the initial invasion of the dermatophyte, gram-negative bacteria grow minimally. These changes are manifested as progression from an uncomplicated superficial fungal infection