1.0 INTRODUCTION AND AIM OF THE WORK

The essential feature of tinea capitis is invasion of hair shaft by dermatophytes. Most dermatophyte species are capable of invading hair but some species e.g. M.audouini, T.schoenleini, and T.violaceum have a distinct predilection for the hair shaft. Tinea capitis is predominantly an infection of children, probably because of differences in the sebum secretion between children and adults as adult sebum has a fungicidal effect *(Clayton et al., 1977)*. However, tinea capitis has occasionally been reported in adults, particularly with T.tonsurans infections and in patients with AIDS *(Elweski, 2000)*.

It has been found, from a classical experiment on M.audouini, that invasion of the stratum corneum of the scalp must first develop before infection of the actual hair occurs *(Kligman, 1955)*. Observations also suggest that the survival and propagation of the dematophyte is pH-dependent and that the optimium acidic PH is provided by the presence of large amounts of hyaluronic acid in the outer root sheath of anagen hair *(Graham et al., 1964)*.

Currently, tinea capitis is treated by systemic antifungal medications e.g. terbinafine, azole drugs or griseofulvin. Systemic treatment is mandatory in tinea capitis as local treatment is usually ineffective. Disadvantages of systemic treatment include high cost, more likely side effects, and long duration that may lead to non-compliance *(Krowchuk et al., 1983)*.

Some decades ago, tinea capitis was treated by total epilation of hair through systemic administration of thallium acetate or by local x-ray followed by local application of antifungal remedies. However, subsequent studies on this modality of treatment have reported increased incidence of malignancy especially skin, thyroid, brain, salivary gland and breast carcinoma *(Ron et al., 1989)*.

Recently, several types of lasers have been available to target the hair follicle e.g. long pulsed Nd:YAG, alexandrite or diode lasers. Till now, they are mostly used for the treatment of hirsutism *(Kilmer et al., 1999)*. Long-pulsed Nd:YAG laser (1064nm) has been approved by the FDA for laser hair removal on all skin types. Laser hair removal is most successful when the hair is in its anagen phase. In the human scalp, this phase lasts several (≈ 3) years and

at any given time; eighty five percent of scalp hair is in that phase. During this phase the hair is easily targeted and destroyed by laser *(Tanzi and Alser, 2004)*. The Nd:YAG laser pulse produces both mechanical and thermal damage to the hair follicle due to rapid temperature rise and cavitations associated with sudden evaporation of water and local shock waves. This is subsequently followed by introduction of hair follicle into telogen stage for several weeks *(Goldberg et al., 1997)*.

As Nd:YAG laser affects mainly anagen hair, the phase which is involved in tinea capitis, it may be tried for the treatment of tinea capitis in a way similar in principle to (but apparently much more safe than) the past practice of X-ray or thallium- induced hair epilation.

AIM OF THE WORK

The aim of this work is to evaluate the use of long pulsed-Nd:YAG laser (1064nm) as a means of introducing hair follicles into telogen phase in the context of treating tinea capitis in combination with topical antifungal medication.

2.0 Tinea Capitis

2.1 Definition:

The essential feature of ringworm of the scalp is the invasion of hair shafts by a dermatophyte fungus. Tinea capitis is predominantly an infection of children, although adult cases are seen particularly with trichophyton tonsurans infections due to sensitivity of microsporum audouini to griseofulvin and importing of T.tonsurans by emigrants. Unlike M.canis and M.audouinii, tinea capitis caused by T.tonsurans does not necessarily resolve at puberty *(Clayton et al., 1977)*. Tinea capitis may also be seen in adults with AIDS and other immunosuppressed patients *(Elweski, 2000)*.

2.2 Species Concerned

Most species of dermatophyte are capable of invading hair but some species (e.g., Microsporum aduoini, Trichophyton schoenleinii and Trichophyton violaceum) have a distinct predilection for the hair shaft. Epidermophyton floccosum, T. concentricum and T. mentagrophytes var. interdigitale are exceptional in apparently never causing tinea capitis *(Welsh et al., 2006)*.

The species concerned and the sources of tinea capitis are listed in table 1.1

Table 2.1: Sources of Tinea Capitis *(Welsh et al., 2006)*

Species	Sources
Anthropophilic	
Microsporum audouini	Infected individuals, combs, brushes, towels and furniture.
Trichophyton tonsurans	
T.violaceum	
T.schoenleini	
Zoophilic	
M.cains	Dogs, cats
T.mentagrophytes (var mentagrophytes)	Animals, soil
T.verrucosum	Cattle, fomites
M.nanum	Pigs, soil in pigsties.
Geophilic	
M.gypseum	Soil

The species of dermatophyte fungi most likely to be causing tinea capitis vary from country to country and from region to region *(Brajac, 2004)*. Moreover, in any given location, the species may change with time, particularly as new organisms are introduced by immigration. It is of interest that in tinea capitis anthropophilic species predominate *(Hallgren et al., 2004)*.

The principal feature of tinea capitis in the last decade has been the rise of M. canis as the dominant causative organism in infections in some parts of Europe *(Ginter-Hanselmayer et al., 2002)* and the spread of T.tonsurans in urban communities in USA *(Elewski,2000)*. A similar rise in the prevalence of T.tonsurans has recently been recorded in urban areas of the UK and in some other European countries *(Viguie-Vallanet et al., 2005)*.

2.3 Epidemiology

2.3.1 Age and Race

Tinea capitis is the most common pediatric dermatophyte infection worldwide. In the United States, the highest incidence of tinea capitis infections occurs in 3 to 7 year-old children *(Elweski, 2000)*.

Worldwide, pre-adolescent children are most commonly affected *(Menan et al., 2002)*. Tinea capitis also has been described in neonates. Infantile cases caused by either M.canis *(Romano et al., 2001)* or T.tonsurans have been also reported worldwide *(Ismail et al., 2003)*.

The age predilection is believed to result from the presence of pityrosporum orbiculare (pityrosporum ovale) as a part of normal flora in adult skin and the fungistatic properties of fatty acids of short and medium chains in post pubertal sebum *(Dolenc-Voljc, 2005)*.

Surveys of normal human scalp indicate that pityrosporum ovale is nearly always present and is usually the dominant yeast species in adult scalp *(Martin-Scott, 1952)*.

Whitelock, (1953) thought that seborrhoea and high levels of pityrosporum ovale carriage were associated (lipophilic yeast flora). *Weary, (1968)* has shown that the pityrosporum ovale may have some inhibitory action against dermatophyte fungi. This may partly explain the resistance of adults to scalp ringworm.

2.3.2 Sex:

Incidence of tinea capitis may vary in both sexes, depending on the causative organism. In M.audouinii-related tinea capitis, boys are affected much more commonly. In infection with M.canis, the ratio varies and the infection rate usually is higher in male children. On the other hand girls and boys are affected equally by trichophyton infections of the scalp, but in adults, women are infected more frequently than men due to exposure to children and hormonal changes *(Gumusay and Ilkit, 2006)*.

2.4 Contagion

Fungal transmission may occur through contact with actively infected persons, carriers, contaminated objects, infected animals, or soil *(Sharma et al., 2001)*.

2.5 Asymptomatic carriers

Asymptomatic carriers in the home and at school may aggravate epidemic spread of tinea capitis *(Vargo and Cohen, 1993)*.

Mounting evidence suggests that a large reservoir of asymptomatic infections may play a role in the spread of tinea capitis. In certain parts of Africa

where tinea capitis is usually caused by T.violaceum, up to 41% of asymptomatic school- aged children are carriers *(Neil et al., 1990)*.

Adults may act as carriers as well. In one survery, 29% of asymptomatic mothers of children with tinea capitis had positive scalp cultures *(Barlow and Saxe, 1988)*.

Babel and Baughman, (1989) recovered fungus from the scalp of 14 of 46 (30%) asymptomatic adult contacts of children with tinea capitis.

More than half of the untreated carriers remain culture positive after two months. Semiquantitative assessment of spore loads demonstrated that carriers in general have lower spore counts than symptomatic individuals and that asymptomatic carriers with higher spore counts are more likely to remain carriers after 2 months than those with lower counts *(Silverberg et al., 2002).*

2.6 Pathogenesis

The spores of ringworm fungi causing tinea capitis can be demonstrated in the air in the close proximity to patients with the condition. It is highly likely that the scalp hair acts as a trapping device and

it is known that contamination of hair without demonstrable clinical finding may occur among classmate of children with tinea capitis *(Kligman, 1952)*.

From the classical experimental work of Kligman on M. audouinii, it is clear that if actual hair infection is to occur, invasion of stratum corneum must first develop. Trauma would assist inoculation which is followed after approximately three weeks by clinical evidence of hair shaft infection, spread to other follicles proceeds, then for a period of variable duration the infection persists, but does not spread further. Finally there is a period of regression with or without an inflammatory phase (*Kligman, 1955)*.

2.6.1 Types of hair invasion:

There are several distinct types of hair invasion as shown in Fig. (2.1)

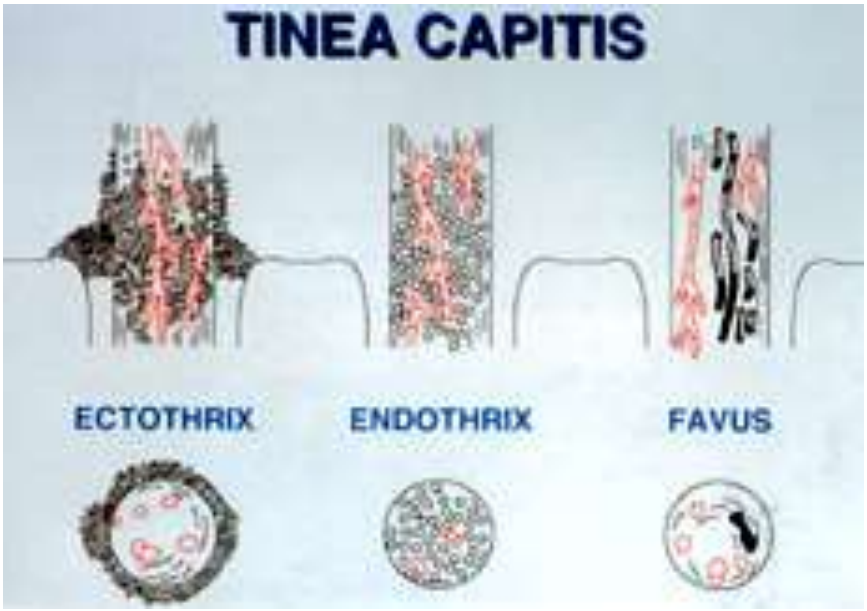

Fig. (2.1): Types of hair invasion.

2.6.1.1 Small spored ectothrix:

This may be caused by M.audouinii, M.audouinii var. rivalieri, M.canis, M.canis var. distortum, M.equinum or M.ferrugineum. In this type, the hair shaft is invaded in the mid-follicle. The intrapilary hyphae continue to grow inward towards the bulb of the hair. Secondary extra-pilary hyphae burst out and grow in a tortuous manner over the surface of the hair shaft, which is growing outwards continuously *(Altindis et al., 2003).*

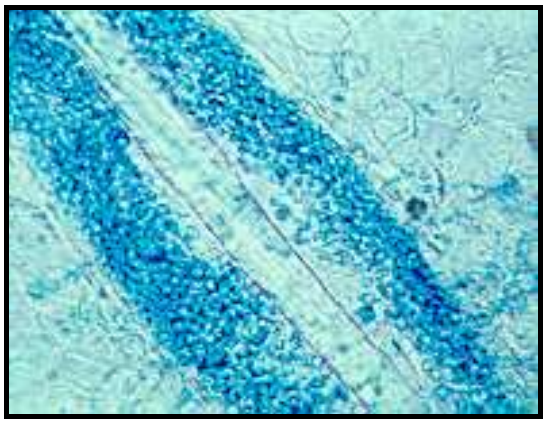

Fig. (2.2): Small Spored Ectothrix.

These secondary extra-pilary hyphae segment to produce a mass of small arthroconidia which are 2-3μm in diameter and eventually become rounded off and spherical in shape. The size of these conidia is so small in such that it cannot be easily distinguished as a separate structure under a low powered microscope ***(Pipkin, 1952).***

Fluorescence under the Wood's light is characteristically present in this type of hair invasion. A similar type of hair invasion occurs with other Microsporum species e.g., M.gypseum, M.fulvum, M.nanum. These spores, although similarly arranged, are larger, measuring about 5-8 μm. Fluorescence has been reported in some cases ***(Akpolat et al., 2005)***.

2.6.1.2 Large spored ectothrix:

The second form of hair invasion is usually caused by T.verrucosum, T.mentagrophytes and T.megninii. The arthroconidia are spherical, arranged in straight chains and again confined to the external surface of the hair shaft. The spores on the surface are derived from primary extrapilary hyphae that have never invaded the shaft, the cuticle of the hair is destroyed. Although the size varies with species, measuring up to 10 μm in the case of T.verrucosum, they are all larger than those seen in small-spored ectothrix, Micro-sporum infection, and individually distinctly visible under a low power microscope. However, there is no flurescence under Wood'slight *(Jha et al., 2006).*

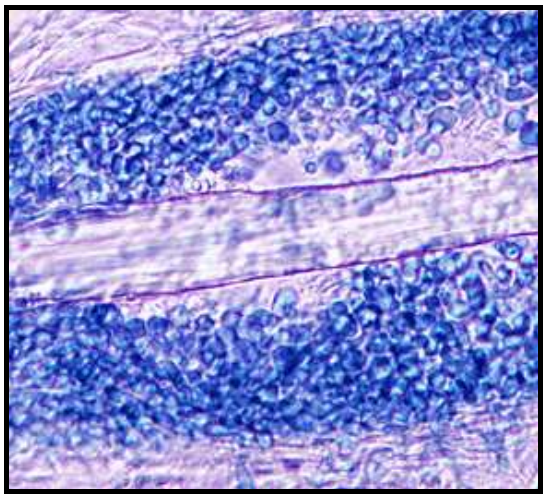

Fig. (2.3): Large Spored Ectothrix.

2.6.1.3. The endothrix type:

This type is caused by T.tonsurans, T. soudanense, and T. violaceum. Intra-pilary hyphae fragment into arthroconidia which are entirely contained within and completely fill the hair shaft, the cuticle of which remains intact. The size of these arthroconidia can reach up to 8μm. Hair affected is especially fragile and breaks off close to the scalp surface leading to black dot ringworm. This type is non-fluoroscent *(Muir et al., 1984)*.

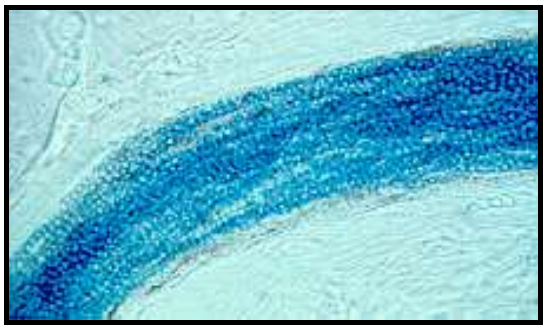

Fig. (2.4): The Endothrix type.

2. 6.1.4.The favic type:

This type is caused by T.schoenleinii. Broad, regularly septate hyphae and air spaces are seen in the hair shaft but disarticulated arthroconidia are absent. The affected hair shaft is less damaged than in other types, and may continue to grow to considerable lengths. Greenish fluorescence is