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Short Communication

Dermatophytosis: A Highly Infectious Global Fungal Disease of Major Public Health Concern

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Skin is the largest organ of the body that protects the underlying muscles, ligaments, bones, and visceral organs from foreign pathogens, such as viruses, bacteria, fungi, and parasites, which are known to cause various dermatological problems. Among this, dermatophytosis, generally known as ringworm or tinea, is one of the most frequently encountered skin diseases in medical and veterinary hospitals of the world and is important from public health and economic point of view. The disease is reported from over 145 countries of the world including India. It is estimated that about 20 to 25% of the world population is affected with dermatophytosis. In Africa, dermatophytosis is a common skin condition affecting more than 30% of children in primary schools. The prevalence of dermatophytosis was found to be about 75% in Indian population. Disease can occur in sporadic as well as in epidemic forms. The ringworm of the scalp in children due to *Microsporum audouinii* was first time recorded by David Gruby in 1840. Dr. Raymond Sabouraud, a French Dermatologist, in 1894 established the role of *Trichophyton mentagrophytes* in the etiology of ringworm in cattle. *Microsporum canis* was isolated from ringworm lesions in horse and dog by Bodin (1896) and Bodin and Almy (1897), respectively. Fox and Blaxall in 1896 demonstrated for the first time that cat can transmit ringworm to humans and therefore, elucidated the zoonotic significance of animal dermatophytes. In India, the first case of dermatophytosis was described by Powell in 1900 from Assam. The most common species isolated from India is *Trichophyton rubrum*. Recently, *Microsporum canis* emerged as a global dermatophyte that affects humans as well as animals. The incidence of disease varies from country to country depending on climatic, social, and economic factors. A plethora of factors, such as age, sex, occupation, standards of living, personal hygiene, diabetes, animal husbandry practices, and environmental conditions predispose the individuals to ringworm infections. The researchers from different parts of the world have revealed that animals serve as an important reservoir of ringworm infection to humans. Comprehensive studies conducted by Mahendra Pal in the last four decades reported that a wide variety of animals, such as buffalo, camel, cattle, dog, goat, horse, monkey, rabbit, and poultry can be the source of infection to human beings. Dermatophytosis is an important occupational mycozonosis of dairy farmers, animal handlers, pet owners, livestock raisers, kennel attendants, butchers, abattoir workers, laboratory employees, zoo personnel, veterinarians, and bird keepers. Generally, the disease is frequently observed among people of low socioeconomic status and in rural areas. Males are more commonly affected than females. The outbreaks of dermatophytosis are reported in schools, sport centers, army camps, industrial plants, and swimming pools.

The disease is caused by dermatophytes, which invade superficial keratinized tissues of the body, such as skin, hair, and nail of humans and animals. Dermatophytes are Gram positive, non-acid fast, aerobic, non-motile, non-capsulated filamentous fungi, which belong to three genera, such as *Epidermophyton, Microsporum,* and *Trichophyton*. Depending on their habitats, dermatophytes are described as anthropophilic (human eg. *Epidermophyton floccosum*, *Microsporum audouinii, Trichophyton rubrum, T. violaceum*), geophilic (soil e.g. *Microsporum gypsum*) and zoophilic (*Microsporum canis*, *M. equinum*, *Trichophyton simii*, *T. verrucosum*), and all are implicated in the etiology of dermatophytosis. Dermatophytes grow well at 25^0C to 30^0C and can survive for years in the inanimate environment. Dermatophytic fungi are susceptible to common disinfectant particularly those containing chlorine, iodine, and cresol. Dermatophytes prefer to grow in warm and humid environment and are therefore, more widespread in tropical and subtropical regions of the world. Some of the dermatophytes, such as *Epidermophyton floocosum*, *Microsporum canis*, *Trichophyton rubrum*, and *T. verrucosum* are distributed all over the world whereas

others like *Microsporum ferrugineum*, *Trichophyton concentricum*, *T. gourvilii*, *T. simii*, *T. soudanense*, and *T. yaoundei* have geographical restriction. Recently, due to migration of people from South American countries, *T. tonsurans* has replaced *M. audouinii* as the major agent of tinea capitis in the United States of America. It is pertinent to mention that around 90% of chronic ringworm is attributed to *Trichophyton rubrum*.

Humans get the infection through direct contact with infected person or animals. Indirect contact with fungal contaminated fomites, such as towel, comb, napkin, toys, carpet, bedding, floor, cap, hat, handkerchief, barber clipper, theatre seat, slippers, taxi seat, chair, toilet articles, utensils, equipment's etc. may also cause infection. Accidental inoculation of fungal spores through abraded skin can introduce infection. Infection due to geophytic dermatophytes may be acquired by living in close contact with soil. Healthy cats and dogs may remain asymptomatic carriers of dermatophytes, and pose a great risk to human beings, particularly those who remain in contact with pet animals. It is stated that approximately, 30% of dogs and cats in USA are infected with *M. canis*, a frequent cause of ringworm of the scalp in children infection in humans.

The incubation period of ringworm in humans is 7 to 14 days. Depending upon the site involved, dermatophytic infections can be classified as tinea barbae (beard), tinea capitis (scalp, head), tinea corporis (neck, shoulder, and trunk), tinea cruris (thigh, groin, lower abdomen, genital, and perianal area), tinea facei (face), tinea mannum (hand), tinea pedis (feet), and tinea ungums (nail). Symptoms of ringworm infection depend on the type of dermatophytic fungi, age, and immune status of host. The lesions show erythema, papule, vesicle, pustule, scaling, itching, besides dull, lusterless and brittle hair, and thickening and discoloration of nails. Tinea capitis primarily affects the school going children whereas tinea pedis is most commonly observed in male of 20 to 40 years of age. Children are less affected with tinea unguium than adults.

Characteristics circular lesions on the skin may help in tentative diagnose of ringworm. Wood lamp, an ultraviolet source, can be used to examine the skin and hair to detect infections like *M. canis, M. distortum,* and *M. equinum.* These dermatophytes exhibit a bright greenish fluorescence under wood lamp. In certain case, false positive fluorescence may also be observed. The confirmative diagnosis is made by direct microscopic demonstration of hyaline, long branching, septate hyphae and arthropospores in the skin scrapings, nail clippings, and hair from the lesions after digestion in 10 - 20% potassium hydroxide solution. The fungal elements can be highlighted by staining with a solution of Evans blue and calcofluor white. The cultural isolation is attempted form the lesions on Sabouraud dextrose agar with chloramphenicol and actidione and on dermatophyte test medium (DTM). As dermatophytes grow slowly, a positive culture cannot be ruled out until the culture is negative for at least 21 days. The detailed morphology of the dermatophytic fungi isolated from clinical specimens is studied in Narayan stain (4.0 ml of glycerine, 6.0 ml of dimethyl sulfoxide and 0.5 ml of 3% solution of methylene blue), which was developed by Mahendra Pal in 1998. Skin test with Trichphytin and serological test may also be used in diagnosis. Histopathological examination of the skin biopsy by periodic acid- Schiff (PAS) and Griedley fungus staining techniques can also detect dermatophytes. Molecular tools are found helpful to study the taxonomy of dermatophytes. The disease should be differentiated from contact dermatitis, dermatophilosis, eczema, folliculitis, impetigo, malasseziosis, onychodystrophy, psoriasis, scabies, and seborrhoea.

Treatment of dermatophytosis depends upon the site and the kind of lesion. Localized dermatophytic infection is the main indication of topical application of antifungal therapy. Most patients with ringworm infections can be treated with topical antifungal drugs, such as butenafine (1%), butoconazole (1%), ciclopirox olamine (1%), clotrimazole (1%), eberconazole (1%), econazole (1%), itraconazole (1%), ketoconazole (2%), luconazole (1%), oxiconazole (2%), miconazole (2%), naftifine (1%), sertaconazole (1%), sulconazole (1%), terbinafine (1%), terconazole (1%), tioconazole (1%), and tolnaftate (1%).The topical medicines should be applied as a thin layer once or twice a day depending on the therapeutic agents to the affected area for 2 to 3 weeks. Clinical efficacy of terbinafine 1% cream was studied in 16 patients of localized tinea corpois. All the patients showed complete clinical cure at third week of its continuous topical use. The drug was well tolerated with no adverse effects in the treatment of tinea corporis (Pratibha Dave, Personal observation). It is suggested that infants and pregnant women should preferably be treated with topical antifungal drugs. However, systemic therapy with fluconazole (150 mg orally), itraconazole (100 - 200 mg orally) and terbinafine (250 - 500 mg) is suggested in tinea capitis, tinea pedis, tinea unguium, wide spread invasive lesions, recurrent or chronic lesions, unresponsive to topical antifungal drugs, and immunocompromised state. Clinical experience has shown that management of tinea barbae is better with oral medications than topical therapy as affected hair follicles do not respond well with topical drugs. It is advised that itraconazole should be taken immediately after full

meals. People with a history of liver disease should not take oral terbinafine therapy. As oral antifungal drugs may cause some side effects, it is pertinent to monitor the patient during the course of therapy. The duration of treatment may vary from one month to one year depending on the type of tinea and severity of lesions. It is experienced that ringworm infection is persistent and resistant in 10% of the patients. Effective treatment with antifungal drugs can reduce the duration of symptoms and give relief to the patients. It is advised that patient should continue the drugs until clinical cure is achieved. In case of any drug reaction, patient should immediately consult the physician. It is emphasized that early intervention is critical to prevent the spread of infection to others.

Several measures, such as avoidance of topical steroids, and harsh medicated soaps, isolation of diseased person, early diagnosis and treatment, restrain to scratch the affected area, use of disposable gloves during examination of patients, proper washing of hands with antiseptic soap after the examination of patient, sterilization of towel, cap, comb, bed sheet, clothes, etc., regular removal of hair on genitalia, use of disposable paper towel, washing of infected clothes in hot water separately, use of loose, cotton garments, avoiding tight and synthetic clothes, and occlusive footwear, immediate shower after playing contact sports, frequent change of underwear and socks, avoidance of sharing towel, bed linen, napkin, clothes, comb, slippers, saving brush and razor, habit of taking daily bath, drying the skin after bath, wearing slippers in public washrooms, frequent washing of swimming baths, spraying of antifungal powder (clotrimazole, fluconazole, ketoconazole) in shoes, treatment of pets in family, and health education to the public about the source of infection, mode of spread, avoidance of wearing wet clothes, taking daily bath and proper drying of the skin, keeping finger and toe nails short, care and handling of sick animal and animal products like hair, skin, etc., and personal hygiene, will certainly help to reduce the prevalence and incidence of dermatophytosis, which is the most commonly prevalent mycosis in the world.

The immunization of calves with *T. verrucosum* vaccine yielded encouraging results as it could protect 90% of vaccinated calves against *T. verrucosum* infection. Therefore, it is recommended that further research should be conducted to develop potent, safe, and cheap vaccines against the commonly prevalent dermatophytes for the prevention of disease in humans as well as animals. Narayan stain is cheaper than other mounting stains and therefore, its routine application in public health, and microbiology laboratories to undertake detailed morphological studies of dermatophyes, is highly emphasized. As potassium hydroxide technique is simple, easy and cost effective, it should be employed to diagnose ringworm infections in hospitals in remote areas where laboratory facilities for cultural isolation of dermatophytes are not easily available. Since many patients from poor resource nations cannot afford expensive antifungal drugs, hence, sincere attempts should be made to screen a variety of plants to study the efficacy, and safety against dermatophytic fungi, which are implicated in the etiology of disease.

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