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CURRENT UNDERSTANDING ON CANINE AND FELINE DERMATOPHYTOSIS: CLINICAL, DIAGNOSTIC AND THERAPEUTIC PERSPECTIVES

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Abstract

Dermatophytosis (ringworm,tinea), an important infectious cutaneous fungal disease of humans and animals including pets, is reported from many countries of the world including India.It affects around 20–25% of the world's population.Disease is mainly caused by many species of dermatophytes, however, *Microsporumcanis* is involved in most of cases of canine and feline ringworm.Young animals are more frequently affected than adults.Animals can acquire the infection from direct contact with affected animals or humans, from contaminated bedding, hair brushes, food bowls etc. and also from environment.Typical lesions, which consist of focal alopecia, scaling, and thin, greyish white crusts, are mostly observed around the ears, face, muzzle, abdomen, tail, and feet. Direct microscopy in mounting fluid and cultural isolation on mycological media are still widely employedfor diagnosis of dermatophytosis. The detailed microscopic morphology of the isolated dermatophytes can be studied in a newly developed "**Narayan"** stain. The disease should be differentiated from bacterial dermatitis, parasitic infestations, seborrhoea, and neoplasia.Both topical skin ointments(miconazole, clotrimazole, terbinafine) and systemic oral antifungal antibiotics (itraconazole,terbinafine) are used for the treatment of pet animals. The present review focuses on the etiology, clinical spectrum, diagnosis, and treatment of dermatophytosis in dogs and cats. In addition, the public health implications of zoophilic dermatophytes are discussed.

Keywords: Cats, Dermatophytes, Dogs, *Microsporumcanis*,Public health, Ringworm, Zoonotic importance

Introduction

Fungal infections are important cause of morbidity and mortality in humans and animals globally. There are many fungal diseases, such as aspergillosis, blastomycosis, candidiasis, chromoblastomycosis, coccidioidomycosis, cryptococcosis, dermatophytosis, histoplasmosis, paecilomycosis, pesudoallescheriasis, phaeohyphomycosis, rhodotoruliosis, sporotrichosis,trichosporonosis, and zygomycosisthat are reported in humans, and also in animals (Pal,2007). Among this, dermatophytosis also known as ringworm, tinea,is acommonly encountered superficial highly infectious fungal disease of humans as well as animals, and is reported from developingas well as developed countries of the world. The disease is caused by dermatophytes that have the potential to invade the keratinized layers of skin, hairs, and nails.Dermatophytes are filamentous fungi, which have 42 species classified in three genera namely, *Epidermophyton*, *Microsporum* and *Trichophyton* (Pal,2007). Sexual reproduction in dermatophytes can be studied in vitro on the modified Pal sunflowers seed medium that was developed by Pal in 1986 (Pal,2007).Dermatophytic fungi aresensitive to moist and dry heat, and also susceptible to several chemicals like formaldehyde, idophors, sodium hypochorite, idophors, glutaraldehyde, and benzalkonium chloride, (CFSPH, 2013).The young animalsare more vulnerable to ringworm infection as they have under developed immune system.Dermatophytosis is a commonly encountered fungal disease of puppies and kittens (Moriello, 2019).Among many species of dermatophytes, *Microsporumcanis* is recognized as the leading cause of ringworm in dogs and cats (Pal,2007).The fungal spores of *M. canis* in contaminated building can remain viable for about 12 months (Menelaos, 2006).It is mentioned that*M.canis*has been recovered from the healthy dogs and cats, and therefore, it may be a source of infection to the family members (Pal*et al*.,1990).Furthermore, thebroken hairs with spores of dermatophytes are important cause for spread of ringworm infection (Merchant,2018). Microtrauma caused during clipping, grooming or handling of the pet animals may help in the establishment of infection (Moriello,2019). Encouraging results are obtained whentopical medication and systemic oral antifungal drugs are used simultaneously (Moriello *et al*., 2017).The major challenges and perspectives in the diagnostics and treatment of dermatophyte infection has been discussed by Gnat and co-workers (2020). The present communication delineates the diagnostic approaches, and treatment regimens of canine and feline dermatophytosis. In addition,the public health significance of zoophilic dermatophytes is also highlighted.

Etiology

Dermatophytes belonging to the genus *Epidermophyton*, *Microsporum* and *Trichophyton* are implicated in the aetiology of ringworm infections of dogs and cats worldwide. Dogs and cats are the chief reservoir of *Microsporumcanis*

and can transmit the infection to other animals, and also children, who usually remain in close contact with pets (Pal,2007). The following dermatophytes have been isolated from dogs and cats (Ainsworth and Austwick, 1973; Pal, 1981;Wright, 1989; Pal *et al*., 1990;Bernardo *et al*.,2005; Pal and Mahendra,2017).

***Dogs*:**

Several dermatophytes, such as*Epidermophyton floccosum, Microsporumaudouinii, M. canis, M. cookei, M. distortum, M. galliniae, M. gypseum, M. persicolor, M. vanbruseghemii, Trichophyton ajelloi, T. megninii, T. mentagrophytes, T. rubrum, T. schoeleinii, T. simii, T. terrestre,T.tonsurans, T. verrucosum,* and *T. violaceum*are concerned with ringworm infections of pet dogs (Ainsworth and Austwick, 1973; Pal, M. 1981;Yamada *et al*.,1981; Pal,2003; Bernardo *et al*.,2005; Brilhante *et al*., 2006; Pal,2007;Dave*et al*.,2014; Pal and Mahendra,2017) have been isolated from ringworm lesions.In dogs, *Microsporumcanis, M.gypseum* and *Trichophyton mentagrophytes* are responsible for 70%, 20%, and 10% of ringworm cases, respectively (Merchant,2018).

Cats:

Ringworm in cats is caused by many dermatophytes, which include*Microsporumaudouinii, M. canis, M. cookei, M. gypseum, M. nanum, M. persicolor,T. megninii, T.mentagrophytes, T. rubrum, T. schoeleinii, T. terrestre, T. verrucosum,* and *T. violaceum*(Ainsworth and Austwick, 1973; Pal,2003; Bernardo *et al*.,2005; Melenos,2006;Pal 2007, Pal and Mahendra, 2017; Moriello *et al*.,2017).It is described that around 98% of ringworm cases in cats are caused by *Microsporumcanis* (Merchant,2018).

Clinical spectrum

Dogs:

The infection is frequently observed in young dogs less than 1- year-old (Menelos, 2006). Lesions usually occur on the face, lower abdomen, and extremities of dogs (Pal,2003).Circular, crusted lesions are noticed on the shoulder, abdomen, and leg region of dog (Fig.1). The lesions in puppies may show alopecia, scales, vesicles, pustules, and crust. Other forms of dermatophytosis include kerion, and pseudomycetomas. In addition, onychomycosis may occur concurrently with ringworm infection (CFSPH, 2013). Older dogs are less susceptible, and if formerly exposed to dermatophytes, may have developed immunity (Menelaos, 2006).The generalized infection is rarely seen in dogs, and is usually accompanied by immunodeficiency (Aiello and Mays, 1998). In dogs, *Trichophyton mentagrophytes* can cause diffuse, well-definedalopecia, erythema, and crust (Moriello,2019). It is stated that Yorkshire terrier dogs appear to be most likely infected with *M.canis*whereas other breeds of dogs, such as short-German shepherd, fox terrier, beagle, Labrador retriever, pointer, Jack appear to be susceptible to*M. gypseum* and *M.persicolor*probably due to frequent contact with contaminated soil that may serve as a saprobic reservoir for these two dermatophytes (*Moriello et al*., 20017).

Fig,1. Dog showing ringworm lesions

Source: (Pal,2007)

***Cats*:**

The clinical signs of ringworm in affected kittens show bald, scaly, crusted patches with broken hairs. The face, ears,muzzle, chest,back, tail, and feet are most commonly affected in cats (Moriello,2019). Occasionally, claws are also affected. Some cats develop small, solid bumps on the skin (called miliary dermatitis) that itch. Merchant (2018) has reported that cats with extensive ringworm frequently have larger bumps with open sores. Small solid bumps on the skin called as miliary dermatitis has been noticed in some cats (Merchant,2018). More persistent and widespread infections may occur in kittens and longhaired cats (Merchant, 2018).It is mentioned that long-haired cats are at risk of developing subcutaneous nodules of dermatophytosis. These cats have a history of having or having had *M.canis* infection (Moriello *et al*., 2017). Feline mycetoma due to *M.canis* has been described by Kano and co-workers (2009).

Diagnostic approach

A number of tools, such as Wood's lamp, direct microscopy, culture, histopathology, and PCR are employed to diagnose ringworm infections in humans and animals (Pal,2007;Moriello *et al*.,2017; Pal and Mahendra,2017;Moriello, 2019). The pets affected with *M.canis*exhibits a bright greenish yellow fluorescence under UV light.The skin scrapings and hairs from the affected pet animal should be collected before medication from the margin of the active lesions as dermatophytes have the tendency to grow centrifugally (Pal,2007).It is essential that skin lesions, hands, scalpel, and forceps should be properly sterilized with 70%alcohol to reducethe contamination of the clinical specimens. A part of the specimen on clean glass slide is treated with 2 drops of

mixture containing equal parts of 20% potassium hydroxide (KOH) and dimethyl sulfoxide (DMSO) for 5-10 minutes, and then examined under light microscope for the presence of septate branched hyphae and arthroconidia (Pal,2007). The affected hairs show ectothrix and endothrix type of invasion. The culture should be attempted on Sabouraud dextrose agar with chloramphenicol (01 mg/ml) and actidione (0.5mg/ml) (Pal,2007) or dermatophyte test medium (DIM)(Taplin *etal*.,1969). Thelater medium changes the colour from yellow to red within 3 to 7 days at room temperature due to rise in pH through metabolic activity of dermatophytes. As some of the dermatophytesgrow slowly, the incubated media should be examined daily for up to four weeks before discarding as negative.It is advised that plates of the inoculated medium should preferably be sealed with adhesive tapes to reduce the evaporation. The detailed microscopic morphology of the dermatophyte can be made in **NARAYAN** stain that contained 0.5 ml of methylene blue, 4.0 ml of glycerine and 7.0 ml of dimethyl sulfoxide (Pal,2004). The disease should be differentiated from scabies, bacterial folliculitis, malasseziosis, demodicosis, and seborrheic dermatitis (Pal,2007; Pal, 2011). The detailed identification of the dermatophytes can be made as per the guideline suggested by earlier researchers (Baxter and Rush-Munro,1980; Pal,2007).

Current therapy

Treatment of dermatophytosis is challenging due to high cost of antifungal drugs and relapse of infection. It has been observed that healthy petscan recover spontaneously without antifungal therapy (Merchant,2018). However, treatmentmayspeed the recovery,check the spread of infection, and diminish the hazard of transmission to humans and other animals (CFSPH, 2013).

Both topical medication and systemic use of anti-fungal drugs are required for the treatment of dermatophytosis in humans and animals (Pal,2007). Many topical skin ointments, such as 1% ciclopirox olamine, 1% clotrimazole, 1% econazole, 2%ketoconazole, 2% miconazole,1% terbinafine, and 1% tolnaftate are available to treat localized infection(Pal, 2007; Pal and Mahendra,2017). If the number of lesions is limited to one to three, it is advised to apply topical drugon each lesion after the removal of crusts and scales with plastic brush in an enamelled bowl containing with 5% lysol. The drug should be applied on the lesions with wooden spatula every day two times for 2-3 weeks. A shampoo containing 1% terbinafine and 2% chlorhexidine shows encouraging results against *M.canis* and *Trichophyton* species (Moriello *et al*.,2017).In case,pets havingchronic, andwidespread lesions,systemic oral antifungal therapy is recommended. A number of oral antifungal drugs like griseofulvin (25 to 100 mg/kg), ketoconazole (10mg/kg), fluconazole (5 mg/kg),itraconazole (5 mg/kg) and terbinafine (30mg/kg) are used in veterinary clinics (Aiello and Mays, 1998; Moriello *etal*., 2017; Moriello,2019). The use of griseofulvin is contraindicated during pregnancy (Pal,2007).This drug must be given with fatty meal. Furthermore, griseofulvin in cats can result in bone marrow depression and

gastrointestinal problems. It is recommendedto continuetherapy for 2 - 4 weeks after the clinical cure to avoid the chances of relapse (Aiello and Mays, 1998). It is directed that mycological monitoring of therapy is imperative to see the efficacy and response of drugs.The experience has shown that itraconazole and terbinafine are considered as the most effective and safe drugs for treatment of dermatophytosis in pet practice (Moriello *et al*.,2017).

The public health implications of animal dermatophytes have been described by earlier investigators from different parts of the world including India (Pal,1981; Pal,2007; Drouot *et al*., 2009; Pal,2011;Dave *et al*., 2014; Gnat *et al*.,2020; Segal and Eland, 2021). It is recommended that the person dealing with sick animals should take precautions in order to prevent the spread of infection. If there are more than one pets in the family, the diseased animal must be isolated and treated. It is advised that sodium hypochlorite and enilconazole can be used to disinfect the environment that will help to reduce the risk of disease transmission to people as well as other animals (Moriello *et al*.,2017).

Prevention and Control

Measures, such as isolation and treatment of affected pet animal, decontamination of fomites, proper cleaning and disinfection of buildings,quarantine of newly purchased pet and its fungal culture for the presence of dermatophyte, will be very helpful to minimize the prevalence and incidence of dermatophytosis in dogs and cats. As animal dermatophytes are highly communicable to human beings, precautions must be taken to avoid the transmission of infection (Pal, 2007; Pal and Mahendra,2017). It is suggested to use the gloves and apron when dealing with sick animals.Furthermore, immunocompromised persons are advised not to work in pet clinics as many zoonotic infections including dermatophytosis can be acquired from dogs and cats.

Conclusion and recommendations

Dermatophytosis is a highly contagious cutaneous mycosis of animals and humans. It is emphasized that identification of asymptomatic carrier in kennels and catteries can be achieved with culture ofhairs collected by brush technique. Furthermore, routine screening of pet colonies, where *M.canis* is a major problem, can be attempted by Wood's lamp.The pet handlers are advised to frequently wash their hands with antiseptic soap or solutions to avoid the spread of infection to other susceptible ones.Potassium hydroxide technique can be employed to detect dermatophytes in the clinical materials (skin scrapings, hairs) to make the diagnosis at field level where cultural facilities are non-exit or not easily available.Further studies on the development ofsafe, potent, and low-cost therapeutic agents to treatanimal and human dermatophytosis will be awarding.

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