

The presence of dermatophytes in infected pets and their household environment

[Presença de dermatófitos em pets infectados e em seu ambiente domiciliar]

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ABSTRACT

The aim of this study was to diagnose dermatophytosis in pets and investigate the presence of dermatophytes in their home environment. Samples from hair coat were collected from 70 pets: 47 dogs, 19 cats, three guinea pigs and one rabbit. After mycological culture, 188 samples were collected from the household environments in 26 homes: 78 from places were of predominantly used by the tutors, 66 from places used by the animals, 44 from flooring, and 24 samples from contactees. Samples were seeded on Mycosel agar, incubated at 25°C, and the colonies were identified by their macro-and-microscopic characteristics. Dermatophytes were found in 37.1% of the samples originating from the sick animals. *Microsporum canis* was the most prevalent species, isolated in 12 dogs and eight cats; *Trichophyton quinckeanum* in three guinea pigs, *Microsporum gypseum* in two dogs and *Trichophyton mentagrophytes* in one cat. Dermatophytes were found in 69.2% of the surveyed homes; 29.5% of the places/objects predominantly used by the tutors, 42.4% mainly used by the animals, 31.8% from floors, and 50% from contactees. The meeting of dermatophytes in animals and in the household environment confirms the possibility of transmission by direct or indirect contact and their importance in public health.

Keywords: public health, zoonosis, household environment, pets, dermatophytes

RESUMO

O objetivo deste trabalho foi diagnosticar dermatofitose em pets e pesquisar dermatófitos em seu ambiente domiciliar. Colheram-se amostras de 70 pets, 47 cães, 19 gatos, três cobaias e um coelho. Visitaram-se 26 residências dos animais positivos em cultura micológica para a doença, colhendo-se 188 amostras do ambiente: 78 de locais de uso predominante dos tutores, 66 de uso dos animais e 44 de pisos; também foram colhidas 24 amostras de animais contactantes. As amostras clínicas foram semeadas em ágar Mycosel, incubadas a 25°C, e as colônias identificadas por suas características macro e microscópicas. Dermatófitos foram isolados em 37,1% dos animais suspeitos. *Microsporum canis* foi o mais frequente, sendo isolado de 12 cães e oito gatos, *Trichophyton quinckeanum* de três cobaias, *Microsporum gypseum* de dois cães e *Trichophyton mentagrophytes* de um gato. Foram encontrados dermatófitos em 69,2% das casas pesquisadas, isolando-se esses fungos em 29,5% dos locais/objetos de uso predominante dos tutores, 42,4% de uso predominante dos animais, 31,8% de pisos e 50% dos animais contactantes. O encontro de dermatófitos nos animais e em superfícies inanimadas nas residências confirma a possibilidade de transmissão de dermatofitose por contato direto e indireto e sua importância em saúde pública.

Palavras-chave: saúde pública, zoonoses, ambiente domiciliar, pets, dermatófitos

INTRODUCTION

Dermatophytes are filamentous, keratinophilic, fungi responsible for skin lesions in animals and humans (Vermout *et al.*, 2008; Farias *et al.*,

2016). From an evolutionary perspective, these fungi were initially saprobes that later adopted parasitism to cause a common skin disease, i.e., dermatophytosis (Paixão *et al.*, 2001; Balda *et al.*, 2004; Copetti *et al.*, 2006; Coelho *et al.*, 2008; Prado *et al.*, 2008; Farias *et al.*, 2016).

Recebido em 14 de dezembro de 2016

Aceito em 7 de agosto de 2017

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Dermatophytes belong to three fungal genera: *Microsporum*, *Trichophyton*, and *Epidermophyton* (Rebell and Taplin, 1974; Ellis et al., 2007; Farias et al., 2016). *Microsporum canis* is the most commonly found species in dogs and cats (Balda et al., 2004; Copetti et al., 2006; Chermette et al., 2008; Coelho et al., 2008; Farias et al., 2016). Regarding their habitat, they can be zoophilic, anthropophilic, or geophilic, indicating that their reservoirs are animals, humans, or the soil, respectively (Rebell and Taplin, 1974; Chermette et al., 2008).

In general, animals predisposed to dermatophytosis are the young that are under one year old, or the elderly that lack a fully functional immune system (Chermette et al., 2008; Vermout et al., 2008). Dermatophyte infections are seasonal and occur in spring and summer, i.e., during the more humid and warmer months (Chermette et al., 2008; Vermout et al., 2008; Palumbo et al., 2010). Transmission occurs by direct or indirect contact and through contaminated fomites (Chermette et al., 2008; Farias et al., 2016). This is the reason for high incidence of the disease in kennels, catteries, stables, horse farms, and areas with a large number of animals (Gürtler et al., 2005; Pereira et al., 2006; Chermette et al., 2008).

These fungi are highly resistant to various physical and chemical conditions (Chermette et al., 2008) including some disinfectants (Moriello et al., 2002) and can also be isolated from the environment (Mancianti et al., 2003; Sguario and Coutinho, 2008; Segal and Frenkel, 2015).

About two-thirds of human infectious diseases are caused by zoonotic pathogens (Coker et al., 2011). As dermatophyte transmission can occur between animals and humans, this disease is considered a zoonosis, and is therefore an important public health issue (Bilek et al., 2005; Gürtler et al., 2005; Cafarchia et al., 2006; Ferreira et al., 2007; Ali-Shtayeh et al., 2015).

There are very few studies that prove the presence of dermatophytes in the environment or in contaminated fomites. However, these fungi have been isolated from the floor and instruments used in pet shops and veterinary clinics (Mancianti and Papini, 1996; Bagcigil et al., 2010).

The presence of dermatophytes has been confirmed in the air and in fomites from houses where dogs and cats with dermatophytosis are present (Mancianti et al., 2003). In a case report, a cat and its tutor were found to have lesions caused by *Microsporum canis*, and the fungus was isolated from various samples taken from the house, suggesting the possibility of transmission by direct and indirect contact (Sguario and Coutinho, 2008). Therefore, it is essential to study and better understand the epidemiology of transmission of these diseases in the home microenvironment.

The aim of this study was to diagnose dermatophytosis in pets with clinically consistent lesions, and to investigate the presence of dermatophytes in their home environment.

MATERIALS AND METHODS

During clinical examination, veterinarians selected animals that had lesions suggestive of ringworm. The samples from the hair coat were collected from 70 pets, of which 33 (47.1%) were males and 37 (52.9%) were females, all of the different ages. Of these samples, 47 (67.1%) were from dogs, 19 (27.1%) from cats, three (4.3%) from guinea pigs (*Cavia porcellus*), and one (1.4%) from a rabbit (*Oryctolagus cuniculus*). All procedures were carried out in accordance with the guidelines issued by the Ethics Committee on Animal Use (Protocol n. 298/14). We also collected 24 samples from other animals that had some contact with the infected animals (named contactees) and these were from 14 dogs, nine cats, and one guinea pig.

The samples were collected rubbing the hair coat of the animals with a sterilized square of carpet (25cm²) (Mariat and Adan-Campos, 1967). After confirming dermatophytosis by mycological culture, 26 homes where the infected animals were kept were visited and 188 samples were collected from various household environments. The sites of sample collection, e.g., objects or places, were decided after consulting the animal tutors. Many of these places were commonly used by both humans and animals, but were categorized as follows:

The presence of dermatophytes...

- The places that were predominantly used by the tutors (sofas, chairs, cushions, beds, sheets): 78 (41.5%) samples.
- The places predominantly used by the animals (animal houses, cribs, blankets, toys, feeders): 66 (35.1%) samples.
- The general flooring (carpet, wood): 44 (23.4%) samples.

Samples from these microenvironments were collected as described above.

Samples from both animals and the environment were seeded on a plate with Mycosel agar (*Mycosel*TM BD-BBL, São Paulo, Brazil) by gently pressing the carpet on to the agar surface. The plates were incubated at 25°C for a maximum of four weeks.

Colonies were submitted to microculture on potato dextrose agar (*Microbiology*, Merck, Germany), preparations stained with lactophenol-cotton-blue, and fungi identified based on macroscopic and microscopic characteristics (Rebell and Taplin, 1974; Ellis *et al.*, 2007). Additional tests, such as growth at 37°C and hair perforation, were also carried out (Rebell and Taplin, 1974; Ellis *et al.*, 2007).

Chi-square test ($P \leq 0.05$) was used to compare the prevalence of the disease in relation to sex, age, and seasonality, and the frequency of dermatophytes according to the origin of the objects in the households (Glantz, 2013).

RESULTS

Dermatophytes were found in 37.1% (26/70) of the samples originating from the sick animals. *Microsporum canis* was the most prevalent dermatophyte and was isolated from 20 animals (20/26-76.9%), 12 dogs and eight cats. *Trichophyton quinckeanum* was isolated from three guinea pigs (3/26-11.5%), *Microsporum gypsum* from two dogs (2/26-7.7%) and *Trichophyton mentagrophytes* from one cat (1/26-3.8%).

Dermatophytes were isolated from 29.7% (11/37) of the females and 45.5% (15/33) of the males, and this difference was not significant.

Fungi were isolated at a higher percentage (statistically significant) from animals less than one-year old (18/26-69.2%), followed by animals between one and eight years old (7/26-26.9%), and least from above eight-year old animals (1/26-3.8%).

With respect to seasonality, there were a higher number of cases in the spring (10/26-38.5%), although no statistically significant differences were observed among the seasons.

The same species of dermatophytes were detected in animals with lesions and isolated from their homes. Dermatophytes were found in 69.2% (18/26) of the surveyed homes. Among the samples taken from the household environment, 34.6% (65/188) were positive for dermatophytes (Table 1).

Dermatophytes were present in 29.5% (23/78) of the places/objects predominantly used by the tutors, and in 42.4% (28/66) places/objects mainly used by the animals. Among the samples collected from the floor, 31.8% (14/44) were positive for dermatophytes. Statistically, the frequency of dermatophyte isolation was similar, regardless of the site from where it was collected at home (Table 1).

In the contactees, 50% (12/24) of the animals had viable spores on their hair coat; two animals (16.7%) presented with lesions while the other ten (83.3%) had no apparent injuries (Table 1).

DISCUSSION

Viable fungal spores were found in the environment, weeks after the sick animals had been treated with antifungal drugs and showed healing of the lesions. Sick animals were the source of infection for other animals and humans, and it was possible to verify both intra- and interspecies cross-infection within the same residence.

Table 1. Presence of dermatophytes in the household environment of infected pets

	Absolute Number	%
Total homes	26	100.0
Positive homes	18/26	69.2
Total of the environmental samples	188	100.0
Places predominantly used by the tutors (sofas, chairs, cushions, beds, sheets)	78/188	41.5
Places predominantly used by the animals (animal houses, cribs, blankets, toys, feeders)	66/188	35.1
General flooring (carpet, wood)	44/188	23.4
Positive samples	65/188	34.5
Positive samples in places predominantly used by the tutors	23/78	29.5
Positive samples in places predominantly used by the animals	28/66	42.4
Positive samples in general flooring	14/44	31.8
Total samples collected from contactees	24	100.0
Positive samples in contactees	12/24	50.0

Dermatophytes were isolated from 37.1% of the suspected clinical cases demonstrating that considering only the appearance of lesions to start treatment may lead to misdiagnoses and thence to treatment failure. In Brazil, according to the published literature, the confirmation of suspected clinical cases ranges between 18% and 23%, which is lower than what we have reported (Paixão et al., 2001; Brilhante et al., 2003; Copetti et al., 2006). It is possible that these variations could be due to individual skills of the clinicians in suspecting infection.

The fungal species isolated from infected animals were the same as those identified in their home environment, suggesting that these animals were acting as a source of infection and as disseminators of fungi in their homes.

Microsporum canis is the most common agent of dermatophytosis in pets in Brazil and other countries (Paixão et al., 2001; Brilhante et al., 2003; Balda et al., 2004; Copetti et al., 2006; Prado et al., 2008; Palumbo et al., 2010). This fact is further supported by the data presented here, as this species was isolated from 76.9% of the infected animals

Microsporum canis was also isolated in 88.9% (8/9 animals) of cats with ringworm. This fungus is zoophilic, and cats are considered its natural reservoir, as it can be isolated from about 60% of all cats, even in the absence of lesions (Iorio et

al., 2007; Betancourt et al., 2009; Ferreiro et al., 2014).

Trichophyton quinckeanum is a zoophilic fungal pathogen found in rodents (Bilek et al., 2005; Ellis et al., 2007). In accordance with the cited literature, this species was isolated from three tamed guinea pigs with superficial lesions.

In concordance with the results from earlier studies, no differences were observed in the prevalence of the disease between males and females (Paixão et al., 2001; Balda et al., 2004; Palumbo et al., 2010).

Animals less than one year of age were the most affected (69.2%); this observation is in line with previous reports (Brilhante et al., 2003; Balda et al., 2004; Beraldo et al., 2011). It is possible that the higher incidence of ringworm in younger animals was due to their immature immune system (Chermette et al., 2008; Vermout et al., 2008).

Previous studies show a high prevalence of dermatophytosis during spring and summer (Chermette et al., 2008; Vermout et al., 2008; Palumbo et al., 2010). We also found that the greatest number of cases was recorded in spring (38.5%), although no statistically significant difference was noted in the frequency of disease among the seasons. It is probable that the warm and humid climate of Brazil supports the growth

and maintenance of these fungi throughout the year.

Almost all published studies provide information on dermatophytes isolated from animals and their human contactees, but they do not address the presence of dermatophytes at the environmental interface between animals and humans. In this study, dermatophytes were found in many of the surveyed houses (69.2%). This finding is similar to that reported by a study from Italy, which noted the presence of dermatophytes in 76% of the homes that were cohabitated by infected dogs and/or cats (Mancianti *et al.*, 2003).

The samples from various areas in the households were divided according to their greater use by either the tutors or animals, in order to check whether there was a higher occurrence of fungi in samples with different origins. We found that the places/objects contained similar percentages of viable spores of dermatophytes (differences were nonsignificant), regardless of their origin and using by humans or animals. In many households, numerous colony-forming units were isolated from the locations such as bed sheets, sofas, and backpacks of the residents. These findings have practical importance for the epidemiology and transmission of dermatophytosis as it is clear that people and other animals in the same household can acquire the infection by fomites and not only by direct contact with the infected animals.

In another study, the samples from 30 houses that were co-occupied by sick animals were divided into two categories, viz., from "smooth surfaces" (floors and furniture) or "soft" (carpets, sofas) areas. These authors detected no difference in the rates of isolated fungi with respect to their source (Mancianti *et al.*, 2003). In a case report in São Paulo, where three-month-old cat was housed, the tutor had lesions caused by *M. canis*, and this fungus was isolated from bed sheets, chairs, and the carpet (Sguario and Coutinho, 2008). Studies conducted in pet shops and veterinary clinics showed that *M. canis* could be isolated from three blades and a toothbrush (Bagcigil *et al.*, 2010), and several species of dermatophytes were isolated from samples taken from the floors (Mancianti and Papini, 1996). All these reports confirm the possibility of disease transmission through indirect contact (Segal and Frankel, 2015).

Cleanliness and hygiene are crucial to reduce the number of spores in the environment, and a greater hygiene in the homes, pet shops, and veterinary clinics will result in reduced risk of infection (Mancianti and Papini, 1996; Mancianti *et al.*, 2003). It is difficult and sometimes impossible to achieve complete environmental decontamination due to the resistance of dermatophytes to chemicals such as alcohols, phenols, and anionic detergents (Moriello *et al.*, 2002). However, other disinfectants, such as sodium hypochlorite, benzalkonium chloride, glutaraldehyde and lime sulfur, may be more useful (Moriello *et al.*, 2002).

In this study, dermatophytes were isolated from 50% (12/24) of the contactees; of these, ten (10/12-83.3%) had no lesions and represent asymptomatic carriers that helped spread the fungus within the residence and were sources of infection for human contactees. In several homes, there were children and babies, who are more predisposed to these infections (Cortez *et al.*, 2012). In one such case, a child owning a guinea pig infected with *T. quinckeanum* presented with skin lesions that were confirmed to be caused by the same species, thus reaffirming that different animal species can play some role in the transmission of dermatophytosis.

Lately, the contact between humans and pets is becoming more intimate, leading to closer contact between them in the same space in homes and making dermatophytosis as a significant health concern to humans and in veterinary clinics. It is believed that the incidence of mycotic zoonosis, such as dermatophytosis, is increasing as a result of such interspecies interaction as is the possibility of reinfection due to the spreading of spores in the environment (Cafarchia *et al.*, 2006; Ferreiro *et al.*, 2007; Ali-Shtayeh *et al.*, 2015).

From a public health perspective, diseases occur due to multiple circumstances, including intensive agriculture and trade practices, deforestation, closer contact with wildlife, and urbanization (Coker *et al.*, 2011). Nowadays, infectious diseases seem to follow the concept of One-World One-Medicine One-Health (Coker *et al.*, 2011) and this report exactly reflects such a situation. Overall, the houses surveyed in this

study appeared to have an unhealthy environment with viable fungal spores in fomites found inside the houses and interaction between healthy and sick humans and animals.

Dermatophytosis is also a public health concern because a higher incidence is related to the socioeconomic status of people living in the periphery of urban centers, where there is a lack of essential public services, such as safe drinking water, wastewater disposal services, and garbage collection (Gürtler *et al.*, 2005; Cortez *et al.*, 2012; Ali-Shtayeh *et al.*, 2015).

The control of these mycoses depends on the performance at various levels, such as the treatment of both patients and asymptomatic carriers, improving hygiene conditions for humans and animals, and environmental disinfection.

CONCLUSION

The presence of viable dermatophyte spores in the home environment was confirmed by isolating them from various places and objects within the house. It is the responsibility of the veterinarians to provide appropriate treatment to infected animals and their contactees and to guide the tutors in implementing hygiene and disinfection measures in the home environment to reduce the risk of zoonosis.

ACKNOWLEDGEMENTS

Supported by Brazilian Federal Agency for the Support and Evaluation of Graduate Education – CAPES.

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