



Dermatological differential diagnoses in pet owners

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Summary Pets are popular and are kept all over the world. In addition to the many positive psychosocial and physical effects, there are unfortunately, in addition to possible allergic reactions to animals, numerous diseases that can be transmitted from pets and farm animals to their owners that can negatively affect their health. These so-called zoonotic diseases are infectious diseases that are transmitted from animals to humans. The pathogens include bacteria, parasites, fungi, and viruses. Transmission of zoonotic pathogens can occur wherever there is contact with or consumption of animals or animal products. This can occur in connection with domesticated animals, in trade, in hunting, or in research. Zoonoses can also be of importance as an occupational disease in the field of livestock farming. Due to the close relationship between humans and animals, zoonotic diseases are a global public health problem that should not be underestimated. This article discusses some more common zoonoses of the skin that can be caused by pets.

Keywords Zoonoses · Tinea · Swimming pool granuloma · Cat scratch disease · Cowpox · Lyme disease

Introduction

Animals interact with humans in a variety of ways, whether as therapy and service animals, farm animals, wildlife, or in zoos. However, the most common interaction is with pets. It is estimated that 90 million

households in the European Union (46% of all households) own at least one pet [1].

Although pets have positive physical and psychosocial effects on the health of their owners, they may also be the source of various diseases [2]. Diseases transmitted from animals to humans are called zoonoses. These diseases may be caused by bacteria, viruses, parasites, or fungi [3]. Zoonotic diseases can cause a variety of symptoms, including skin lesions. In this mini review, we focus on some dermatologically relevant zoonoses that may affect pet owners.

Dermatological diseases caused by animal contact

Tinea

The term tinea refers to an infection of the stratum corneum of the epidermis, hair and/or nails by specific fungi, the dermatophytes. Dermatophytes include the genera *Trichophyton*, *Epidermophyton*, and *Microsporum* [4]. Sources of infection include humans, domestic animals, wild animals, and soil [5]. Transmission usually occurs through direct contact with infected tissue, dander, or hair containing the fungus. The clinical presentation depends on the particular topography.

Tinea corporis usually begins with a circumscribed folliculitis. Initial findings are usually inflamed, red, slightly scaly, border-accentuated plaques with a centrifugal tendency to expand, and inflammatory follicular papules. As the infection progresses, multiple foci may coalesce into large, map-like areas with central healing. Pruritus is usually present. In rare cases, tinea profunda may form due to an excessive inflammatory response of the organism to the dermatophyte infection. In immunosuppression, erosive and necrotizing tinea corporis may be observed [5].

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Fig. 1 An occipital erythematous swollen area about 4 × 4 cm in size with embedded pustules and honey-yellow crusts associated with infection with *Trichophyton interdigital/mentagrophytes/indotinea*

Depending on the causative agent and the patient's immune status, the appearance of tinea capitis can range from a simple, non-inflammatory seborrheic dermatitis-like condition to alopecic areas with gray-scaly texture or, in the inflammatory forms, granulomatous plaques or nodules ([6]; Figs. 1 and 2).

Diagnosis of tinea infection is usually made by clinical inspection and patient history, as well as microbial diagnostics, including fungal culture and microscopy. Optional diagnostic procedures, such as Wood's light examination and histology, may also be performed. In some cases, PCR (polymerase chain reaction) diagnostics can also be performed, especially when treatments have been unsuccessful or in cases of mixed infections [7, 8].

Therapy depends on the location of the infection and is mainly focused on topical therapy with anti-fungal agents. A systemic therapy may be required in the case of a more severe infection, using agents such as terbinafine, itraconazole, or griseofulvin. Furthermore, it is also important to adequately treat affected pets [9].



Fig. 2 Alopecic areas in tinea infection of the scalp

Cat scratch disease

Bartonella henselae is the main causative agent of cat scratch disease, a bacterial infectious disease transmitted by cat scratches and bites. Cats are the main reservoir for this bacterium. Fleas and ticks are responsible for the transmission between cats [10].

After an average incubation period of 10 days, symptoms such as fever, headache, muscle and joint pain, fatigue, and loss of appetite may occur. Regional lymphadenopathy is common [11]. The lymph nodes are initially indurated and swollen, later fluctuate, and may drain with fistula formation. An erythematous papule or pustule may develop at the site of pathogen entry. Various forms of exanthema may occur (e.g., petechial, morbilliform, or maculopapular) [12].

The diagnosis of cat scratch disease is confirmed by serological tests or PCR. Occasionally, lymph node biopsies may be performed [13]. Most cases are self-limiting and resolve within a few weeks. Mild to moderate courses may require treatment with azithromycin. Immunocompromised patients should be treated to prevent progression to severe systemic disease. Antibiotic regimens such as rifampicin, trimethoprim/sulfamethoxazole, and ciprofloxacin are available for severe disseminated disease. As an external therapy, antiseptic compresses can be used [14].

Swimming pool granuloma

Mycobacterium marinum is the causative agent of swimming pool granuloma. Infection occurs through contact of a skin wound with water containing *M. marinum*, and primarily affects ornamental fish keepers, fishermen/women, and fish processing workers [15]. Rarely, infection can occur during bathing in unchlorinated swimming pools, rivers, or the sea. Transmission can also occur through contaminated objects. Aquarium-associated infections account for 50–80% of all cases [16].



Fig. 3 Multiple erythematous partially hyperkeratotic plaques on the forearm in a patient with swimming pool granuloma

The incubation period is usually 2–3 weeks. Infection mainly affects the forearms and hands, as skin injuries and contact with infected water are most likely to occur here. In addition, the cooler extremities provide the optimal growth temperature for these pathogens (30–33 °C) [17].

Typically, a red to purple, papular, plaque-like, or nodular lesion appears at the entry site (Fig. 3). These skin lesions may also have a verrucous or crusty surface and in some cases form an ulcer [18]. A sporotrichoid spread with inflammatory nodule formation along the course of the draining lymphatic vessels or lymph nodes may occur. If the infection spreads, tendons, bursae, joints, and bones may also be affected, resulting in painful swelling, limited mobility, and fistulae [19].

Swimming pool granuloma is nonspecific in its clinical appearance; therefore, there is often a delay in diagnosis and treatment. A triad of clinical, histological and microbiological detection are therefore essential for diagnosis [20].

Usually, spontaneous healing occurs within 1–2 years. Nevertheless, therapy should be provided to prevent the spread of the pathogens. Antibiotics such as rifampicin, clarithromycin, and ethambutol are common treatment options. Local infections can be treated with doxycycline or clarithromycin, while cotrimoxazole, quinolones, or minocycline can also be used. Combination therapy should be used for extensive infections or systemic involvement. Surgical intervention is possible for smaller foci [16].

Cowpox

Smallpox is a highly contagious disease caused by different subspecies of the variola virus, which belong to the orthopoxvirus genus [21]. The disease is transmitted as droplet and smear infection between humans. The main forms of smallpox include true smallpox (variola major), white smallpox (variola minor), and hemorrhagic smallpox (variola haemorrhagica) [22]. Thanks to a vaccination program by World Health Organization (WHO) and other health organizations, the last natural cases occurred in 1977. Smallpox has been officially considered eradicated since 1980 [23].

In addition to human smallpox, there are also diseases caused by related viruses in a number of animals. Some of these viruses can be pathogenic to humans. *Orthopoxvirus bovis*, the causative agent of cowpox and a close relative of variola virus, is of particular importance. Cowpox resembles, but is much less harmful than, the highly contagious and often fatal smallpox disease. Its close resemblance to the mild form of smallpox and the observation that dairy farmers were immune to smallpox inspired the smallpox vaccine developed and administered by English physician Edward Jenner [22].

Cowpox can occur in various animals such as cows, cats, and rodents. Humans can become infected

through direct contact with infected animals or their excretions as well as through contaminated objects. Cowpox was originally named for its prevalence in cows, but plays an insignificant role in modern cattle farms. Free-ranging cats are more commonly affected today, as they are usually infected via asymptotically infected rodents, and can themselves serve as a source of infection for humans [24].

Typical symptoms of cowpox, which occur within a few days of contact, are severe malaise with fatigue, an itchy, febrile exanthema, swelling of the lymph nodes, and ulcers with a smeary coating at the sites of entry. The skin lesions usually heal within 6–8 weeks with scarring, but can have severe, generalized courses in immunocompromised patients or those with extensive skin disease [25].

Cowpox virus can be diagnosed by laboratory tests such as virus cultures or PCR. Blood tests can also be performed to detect the presence of antibodies against the virus. Diagnosis can also be made based on clinical signs and a history of contact with infected animals [26].

There is no specific treatment for cowpox. In most cases, the disease is self-limiting. In severe cases, treatment of fever and pain symptoms may be required. In rare cases where secondary bacterial infections occur, antibiotics (e.g., clindamycin) may be prescribed [27].

Dermatoses caused by arthropods

Lyme borreliosis

Lyme disease is caused by different species of bacteria of the genus *Borrelia*. While Lyme disease in the United States is caused almost exclusively by *Borrelia burgdorferi sensu stricto* and *Borrelia mayonii*, in Europe there are three other genospecies in addition to *Borrelia burgdorferi* that must be considered: *Borrelia garinii*, *Borrelia afzelii*, and *Borrelia bavariensis* [28].

The disease is mainly transmitted by ticks. In Austria, about 30% of ticks are infected with *Borrelia* [29]. Domestic animals such as rabbits or dogs can bring carrier ticks on their fur into the homes of their owners.

The disease can cause a variety of symptoms that vary depending on the stage. There are three stages: early localized, early disseminated, and late disseminated. In the early localized stage, which occurs within days to weeks of infection, the most common symptom is the appearance of a characteristic rash called erythema migrans (EM). This rash is often circular or oval in shape and may have a central clearing [30].

In the early disseminated stage, which occurs several weeks to months after infection, the bacteria can spread to other parts of the body, resulting in a broader spectrum of symptoms. These may include multiple erythema migrans rashes, neurologic symp-



Fig. 4 Acrodermatitis chronica atrophicans in a patient with positive *Borrelia* serology

toms such as meningitis or facial paralysis, cardiac abnormalities such as chest pain, and musculoskeletal symptoms such as joint pain or swelling [31].

In the late disseminated stage, which occurs months to years after infection, chronic symptoms such as arthritis, neurologic impairment, and skin manifestations such as acrodermatitis chronica atrophicans may occur [32]. In acrodermatitis chronica atrophicans, prominent skin atrophy occurs with extensive livid erythema on the trunk and extremities (Fig. 4).

Lyme borreliosis is diagnosed by the detection of antibodies against *Borrelia* by ELISA or Western blot. PCR tests and culture of the organism from skin lesions or synovial fluid are other diagnostic methods. A careful review of clinical history and characteristic symptoms is required. Clinical diagnosis alone may be sufficient in some cases [33].

Appropriate antibiotic therapy in the early stages leads to complete recovery, thereby preventing severe disease progression and late manifestations [34]. Therapy is stage- and symptom-oriented; doxycycline, amoxicillin, and ceftriaxone are the drugs of choice [35].

Flea bites

Fleas are small, wingless, blood-sucking insects that infest both humans and animals. Important representatives of fleas are the human flea, the dog flea and the cat flea [36].

Since fleas primarily reside in clothing, the bites are mainly found on the covered parts of the body. Flea bites in humans can result in asymmetrically arranged wheals and itchy papules, which, if scratched, can cause secondary infections (Fig. 5). A characteristic feature of flea bites is their multiple occurrence in



Fig. 5 Multiple, grouped, asymmetrically arranged wheals and papules associated with flea bites

a triple configuration, often referred to as “breakfast, lunch, and dinner” [37].

Diagnosis is usually based on history and physical examination. There are no laboratory tests that can confirm fleas as the causative agent of the rash. Instead, the diagnosis can be confirmed by examining residue from the vacuum cleaner and bedding [38].

Symptomatic therapy includes creams with calamine or glucocorticoids. Antihistamines are recommended as systemic therapy to relieve itching. Environmental sanitation is recommended if necessary [39].

Larva migrans cutanea

Larva migrans cutanea is caused by various parasite species, especially hookworm larvae [40]. It can also be caused by larvae of horseflies, threadworms, and tumbu flies. The disease occurs mainly in tropical and subtropical regions [41].

Hookworm larvae are often found in dog and cat feces [42]. When a person walks barefoot over contaminated soil, these larvae can enter the skin. After a few days, at the site of entry, an itchy dermatitis with edema, papules, or papulovesicles may develop. Characteristic are itchy skin passages, which present themselves in a linear or serpentine form and are intensely red ([43]; Fig. 6).

The medical history and clinical presentation are used for diagnosis. External treatment consists of ivermectin cream, tiabendazole ointment, or glucocorticoid-containing topical preparations. In severe courses, systemic therapy with albendazole or ivermectin is possible. Alternatively, cryosurgery may be attempted [44].



Fig. 6 Tortuous, strongly reddened ductal structures in the area of the right forefoot

Pseudo-scabies

The mite *Sarcoptes scabiei* is a parasite belonging to the class of arachnids. The itch mite (*Sarcoptes scabiei* var. *hominis*) causes scabies in humans [45]. In domestic and wild animals, different species of *Sarcoptes scabiei* mite can cause animal mange [46]. Although *Sarcoptes scabiei* varieties do not differ morphologically, they are specifically adapted to different hosts. Occasionally, mites whose definitive hosts are animals can be transmitted to the human integument [47]; in such cases, humans represent a false host. In humans affected by animal mange, mite ducts are usually undetectable [48]. Mites transmissible to humans are found in horses, dogs, cats, rabbits, and pigs [49].

Antiparasitic treatment is usually not required in humans. Symptomatic anti-inflammatory and antipruritic therapy is usually sufficient, e.g., with polidocanol-containing topical preparations or medium-strength glucocorticoids. It is important to treat the affected pets as well [48].

Conclusion

Pet owners should be aware of the risk of zoonotic diseases and take measures to prevent transmission. These include care and hygiene measures, vaccination protection and parasite prophylaxis for pets, and medical care in the event of skin lesions.

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