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VETERINARY MICROBIOLOGY - REVIEW

Feline sporotrichosis in Asia

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Abstract

Sporothrix schenckii sensu *lato* is currently recognized as a species complex with only *Sporothrix brasiliensis*, *Sporothrix schenckii* sensu stricto, *Sporothrix globosa* and *Sporothrix pallida* identified to cause disease in the cat. Feline sporotrichosis in Asia is mainly reported from Malaysia where a single clonal strain of clinical clade D, *Sporothrix schenckii* sensu stricto manifesting low susceptibility to major antifungal classes, has been identified as the agent of the disease. *Sporothrix globosa* has been identified to cause disease from a single cat in Japan while the specific species of agent has not been identified yet for the disease in Thailand. Despite efforts to elucidate and describe the pathogenicity of the agent and the disease it causes, the paucity of data highlights the need for further molecular epidemiological studies to characterize this fungus and the disease it causes in Asia. Its prognosis remains guarded to poor due to issues pertaining to cost, protracted treatment course, zoonotic potential and low susceptibility of some strains to antifungals.

Keywords Feline sporotrichosis · Asia · Malaysia

Introduction

Sporotrichosis is a subacute to chronic infection caused by *Sporothrix schenckii* complex that typically infects the cutaneous or sub-cutaneous tissues in humans and animals. This worldwide infection is found predominantly in tropical to sub-tropical areas. It is currently recognized as a species complex consisting of *Sporothrix brasiliensis*, *Sporothrix schenckii* sensu stricto, *Sporothrix globosa* and *Sporothrix luriei*, united on the fact that they are all able to express increased virulence towards mammals (clinical clade), compared with mildly pathogenic species such as *Sporothrix mexicana and Sporothrix pallida* that is commonly associated with the environment (environmental clade) [1]. In veterinary medicine, *S. brasiliensis, S. s.* sensu stricto, *S. globosa* and *S. pallida* have been documented to cause of disease in cats, while only *S. brasiliensis* has been incriminated to cause clinical sporotrichosis in dogs [2–8]. The disease is historically referred to as 'Rose Gardeners disease', as the most common route of infection is often traced to the inoculation of conidia into broken skin via contaminated soil or plants during horticultural activities. It is only in recent times that the focus shifted to inter-cat aggression in an urban environment as an important risk factor for disease and its subsequent propagation where it was found that cats are particularly susceptible to *Sporothrix schenkii* complex infection, and the disease manifestation is usually severe, unlike that which occurs in other animal species [5, 9–12]. As zoonotic transmission from cats to humans has been reported in increasing frequency in endemic areas, the understanding of the immunopathogenesis of the pathogen in the feline species and the management of cat population in an urban environment is essential to limit and prevent the further spread of this disease [9, 13–15]. In this mini-review, we briefly discuss the status of feline sporotrichosis in Asia, with a focus on Malaysia.

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Epidemiology

S. brasiliensis, currently regionally restricted to Brazil and Argentina is characterised by its inherent thermotolerability which translates to its ability to cause local and systemic disease [16, 17]. This species has been identified as the main

cause of feline sporotrichosis epidemics in Brazil, with *S. s.* sensu stricto isolated in lesser frequency [2, 9, 13]. In Malaysia, the initial observation of the increasingly important role cats played in Sporothrix transmission was first highlighted by Zamri-Saad in 1990, and it was 12 years later in 2012 that a retrospective study of 19 cases of human sporotrichosis confirmed the important role cats played in disease transmission [12, 18]. In this retrospective study, 13/19 (68.4%) of human patients could recall a preceding trauma before the onset of the cutaneous eruption, and of these 13 cases, 7 (53.8%) reported a history of a cat scratch or bite. In this case series, lymphocutaneous sporotrichosis was the predominant clinical form observed in 13 cases (68.4%) [12]. Currently, a clonal strain from clinical clade D of *S. s.* sensu stricto is the only species causing feline sporotrichosis in Malaysia elucidated by sequence analyses of the calmodulin gene and of the ITS region [19]. This clonal strain of *S. s.* sensu stricto clinical clade D from Malaysia, instead of the more commonly isolated clinical clade C in Asia as reported by Zhou et al., suggests that the species is constantly evolving with the ability to undergo a process of purifying selection and subsequent population expansion, dependent on local environmental or host selection pressure. This clonal strain has been identified to be of the same strain which causes sporotrichosis in human patients and is the third most common cause of death in cats undergoing post-mortem in a teaching veterinary hospital where 104 out of 866 post-mortem cases (12%) were attributed by sporotrichosis [20, 21]. Recent clinical case reports of the first feline sporotrichosis from Bangkok, Thailand, and Kartanaka, India, have been reported [22, 23]. However, no speciation nor minimum inhibitory concentration studies were done to ascertain if it is the same clonal strain from Malaysia. Although *S. globosa* is the most common cause of human sporotrichosis in East Asia, only one documented case of *S. globosa*-causing disease in a cat has been recorded from Chiba prefecture in Japan, while *S. pallida* has been identified as an atypical cause of sporotrichosis in a cat from Australia [4, 7]. This paucity of data highlights the need for further molecular epidemiological studies to characterize this fungus and the disease it causes in Asia.

Clinical findings

Feline sporotrichosis occurs most commonly in young adult, free roaming and intact male cats associated with inter-animal aggression with no known breed predisposition. Chronic non-healing ulcers either localized or generalized with granulomatous nodules and crusts are commonly found on the head especially at the bridge of the nose, ear tips, distal limbs or tail base region, typifies the infection in cats. There is a preponderance of lesions to accrue at cooler regions of the host body such as at the nasal passages and especially at the ear tips in cats with sporotrichosis in Malaysia. (Figures 1, 2, 3 and 4)

Fig. 1 A solitary chronic, non-healing and exudative lesion at the paw of a cat with sporotrichosis

The preponderance of lesions to aggregate at these cooler sites, especially at the ear tips, may be due to the lack of thermotolerability of *S. s.* sensu stricto and *S. globosa* isolates compared with *S. brasiliensis* which has the propensity to disseminate in a susceptible feline host [24–26] (Fig. 5). This clinical finding is consistent with thermotolerability studies done on feline isolates of *S. s.* sensu stricto from Malaysia where up to 82% of isolates were not thermotolerant [3]. If nasal passages are affected, extracutaneous signs such as sneezing, dyspnoea and respiratory distress are commonly reported in tandem with cutaneous manifestations [24, 25].

Fatal disseminated form of the disease is associated *S. brasiliensis* infection which has not been reported in Asia, while co-infections with either feline immunodeficiency virus (FIV) or feline leukaemia virus (FeLV) has no significant effect on the final clinical manifestations or the prognosis of the disease in the feline patient [27]. In the human patient, clinical signs of sporotrichosis may be further classified into 3

Fig. 2 Chronic, non-healing ulcers on the bridge of the nose by *S. schenckii* sensu stricto infection of a cat in Malaysia. Note that small granulomas are forming at the tip of both ears

Fig. 3 As the disease progresses, non-encapsulated granulomas form that then ulcerate at ear tips. These exudate then dry to form crusts

forms—fixed cutaneous, lymphocutaneous and disseminated forms, and the extent of which form manifests is attributed to the pathogenicity of the infection species and the status of host immunity. However, such clear and distinct categorisation of clinical forms is not applicable on the feline patient and thus seldom used to describe clinical disease in this species. Recently, secondary screwworm myiasis on skin lesions caused by *Sporothrix* spp. lesions has been reported from Malaysia which further complicates the diagnosis for the veterinarian [28].

Diagnosis

Definitive diagnosis of sporotrichosis requires the isolation, identification plus phase transition of agent in culture and its species identification by morphologic studies and physiologic

Fig. 4 Some cats are presented with generalized, chronic, non-healing nodular lesions at the thorax extending to the abdomen, not just at the head and ear tips

Fig. 5 A dorsal view of a cat with pyogranulomatous nodular and exudative lesions at the ear tips, highlighting the preponderance of the fungus to aggregate at the cooler regions of the host

phenotyping, as well as polymerase chain reaction targeting the calmodulin gene [2, 5, 29, 30].

Colony morphology At 25–30 °C, the fungi exist in its mycelial form and are seen as small and white or pale orange to orange-grey colonies with no cottony aerial hyphae. Some colonies are however black from the onset (Fig. 6a). Later, it is moist, wrinkled, leathery or velvety with narrow white border. At 35–37 °C, yeast colonies are cream or tan, smooth and yeast-like (Fig. 6b) [29].

Cytologic findings The yeasts are found in abundance from impression smears taken from the feline patient where they are located intra and extracellularly, in pleomorphic shapes ranging from the classical cigar-shaped to round or oval yeast, measuring 3–5 μm in diameter with a thin, clear halo around a pale blue cytoplasm (Fig. 7) [31]. The sensitivity of cytology to detect sporothrix yeast in the feline patient is estimated to range from 79 to 84.9% [32, 33].

Pathologic findings Diffuse pyogranulomatous inflammation with large foci of necrosis is seen throughout the superficial and deep dermis which may even extend to the deeper subcutis. Round to cigar-shaped organism, 3–10 μm in length to 1–2 μm in diameter, is seen both free and within macrophages. Commonly, organisms in cytoplasm of macrophages create large clear pockets full of yeast due to poorly visualized yeast cell wall [34] (Figs. 8 and 9). Other than routine haematoxylin-eosin stain (H & E), periodic acid Schiff (PAS) or Gomori's methenamine silver (GMS) stain may also be utilized to visualize yeast organism on histological preparation. Other diagnostic techniques such as serology (enzyme-linked immunosorbent assay, ELISA) and polymerase chain reaction may also be utilised for diagnosis [35, 36].

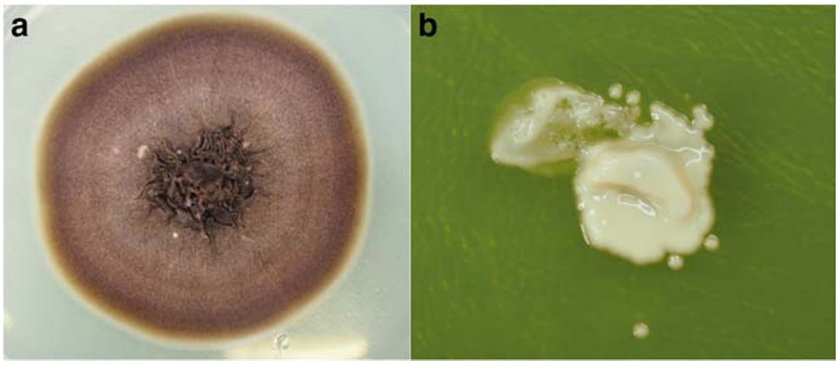

Fig. 6 Colony morphology of *S. schenckii* sensu stricto. Black mycelial form colony was observed on Sabouraud glucose agar after culture at 28 °C for 14 days (**a**). White yeast-like colony was observed on Sabouraud glucose agar after culture at 37 °C for 10 days (**b**)

Differential diagnoses include foreign body reactions (if organisms are not easily seen), histoplasmosis, cryptococcosis, feline herpes virus, squamous cell carcinoma and mycobacterial infection (Figs. 10 and 11). Diagnosis is straightforward as *Sporothrix* spp. organisms are numerous and readily identified on cytological preparation especially from the feline patient. Due to this characteristic, routine in-clinic cytology with Romanowsky-type stain and/or histopathology is the preferred diagnostic option for private veterinarians in Malaysia for a quick diagnosis. Yeast cells of *Cryptococcus* spp. are larger with a clear unstained zone of thick lipid capsule, while those of histoplasmosis and sporotrichosis are similar in size and distribution; typical cigar-shaped, slightly larger organisms of sporotrichosis and the increased prevalence of this infection in cats should allow separation [31, 34]. Confirmatory diagnosis for squamous cell carcinoma will require histopathology while those of herpes virus may require histopathology, polymerase chain reaction, virus isolation or immunohistochemistry (Fig. 12). In the case of mycobacterial infection, the cutaneous lesions are comprised of single or multiple ulcers, abscesses, plaques and nodules (Fig. 13). Infections by *M. microti*, just like *Sporothrix* spp., are predisposed to adult, male cats with no breed predisposition. On cytology, the organism is rod-shaped, refractile and non-staining on routine Romanowsky stains. Acid-fast stains such as Ziehl-Neelsen are needed to positively highlight the organism, and differentiation between mycobacterial species requires culture or polymerase chain reaction (PCR). Currently, due to the lack of accessibility to dedicated veterinary mycological/bacteriological laboratories in Asia and issues pertaining to cost, more specialized test such as molecular diagnostics, fungal culture and susceptibility testing

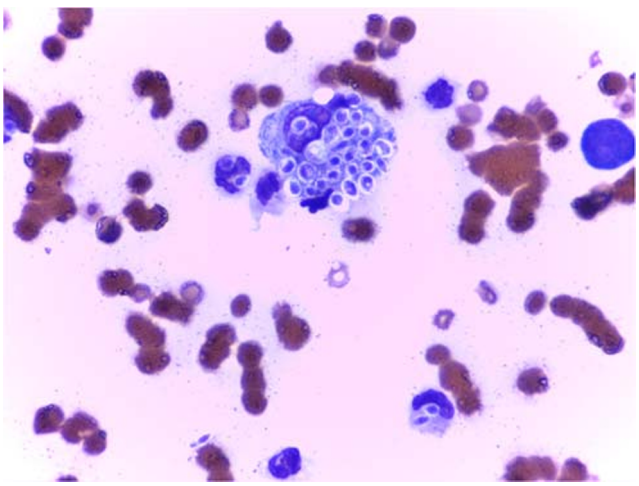

Fig. 7 Yeasts are found in abundance from direct impression smears from the feline patient. They are located intra and extracellularly, in pleomorphic shapes ranging from cigar-shaped to round or oval, measuring 3–5 μm in diameter with a thin, clear halo around a pale blue cytoplasm. Haemacolor stain

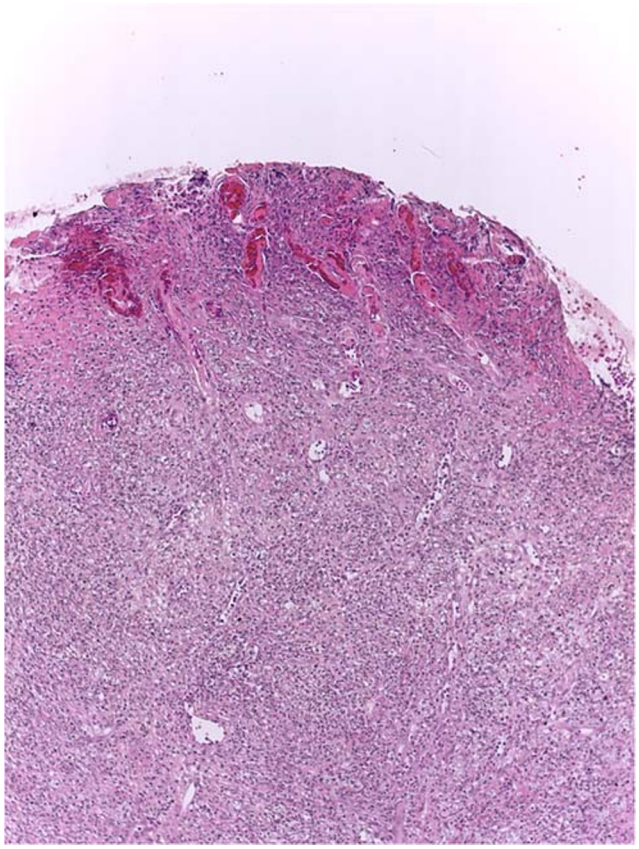

Fig. 8 Diffuse pyogranulomatous inflammation is seen throughout the superficial and deep dermis that may extend to the deeper subcutis

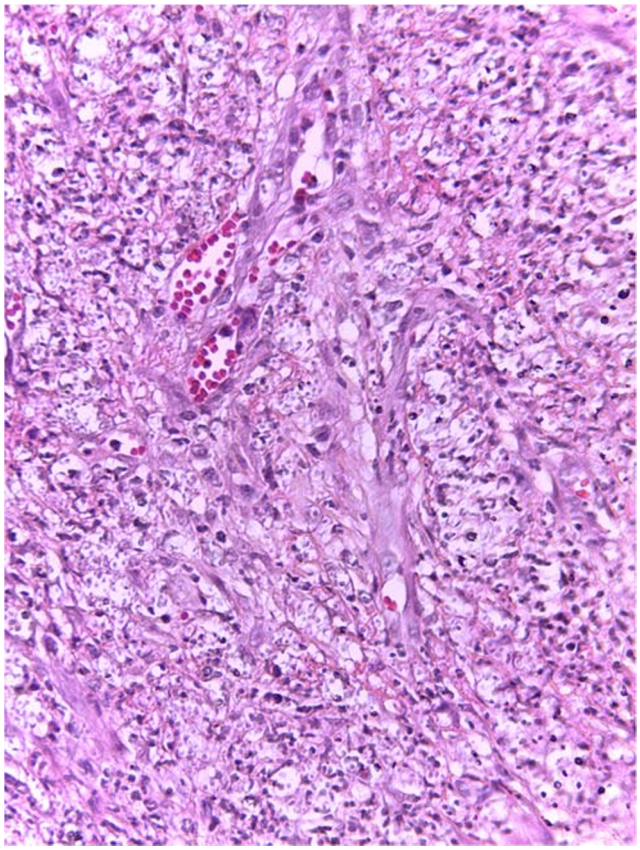

Fig. 9 Round to cigar-shaped organism, seen both free and within macrophages. Commonly, the yeast in cytoplasm of macrophages creates large clear pockets full of yeast due to poorly visualized yeast cell wall

remains out of reach for the veterinarian and pet owners to be assimilated as part of clinical diagnostic work-up. Of the four countries in Asia with reported feline sporotrichosis (India, Thailand, Malaysia and Japan), molecular and susceptibility studies have been reported from Malaysia and Japan.

Treatment and antifungal susceptibility

Treatment of feline sporotrichosis requires several weeks to months and must be continued for at least 1 month beyond clinical cure which translates to high cost of treatment, high risk of therapeutic adverse reactions and high risk of zoonotic transmission, and with the existence of lowly susceptible strains, feline sporotrichosis carries a guarded to poor prognosis. Despite a protracted treatment course, it is current understanding that the fungus does not develop resistance de novo [3]. Currently, potassium iodide, azoles (ketoconazole and itraconazole), amphotericin B, terbinafine, local heat therapy, cryosurgery and surgical resection have been documented as treatment options in the feline patient.

Potassium iodide has traditionally been the treatment for sporotrichosis despite that its exact mechanism of antifungal property remains poorly understood. It has been documented

Fig. 10 A cat with Cryptococcosis. The involvement of the nasal sinuses and occasional cutaneous spread of the disease often confuses the veterinarian between cryptococcosis with that of sporotrichosis

to inhibit neutrophil chemotaxis in peripheral blood, and despite its inability to increase monocyte or neutrophil killing of *S. schenckii*, potassium iodide induces cell degeneration, when the yeast is dipped in various concentration of iodide [37]. Potassium iodide either in its saturated form (saturated salt of potassium iodide, SSKI) or in its powder form re-packaged into capsules has been described to treat sporotrichosis at dosages that ranges from 2.5 to 20 mg/kg every 24 h in the feline patient [38, 39]. The powder form re-packaged into capsules is favoured over SSKI due to the latter's tendency to be bitter which may cause hypersalivation, especially in the feline patient. From a report of 48 cases of cats receiving potassium iodide, 23 (47.9%) patients achieved clinical cure with treatment failure in 18 cats (37.5%), two reported deaths

Fig. 11 A cat with squamous cell carcinoma (SCC) confirmed via histopathology. As the most common form of malignant neoplasm of the feline skin, SCC is associated with sun-damaged skin with the nasal planum, pinnae and eyelids the most common affected sites. Its clinical predisposition site and appearance may be easily confused with that of sporotrichosis

Fig. 12 A cat with herpesvirus-1 (feline rhinotracheitis) infection. There is extensive ulcerative and necrotizing dermatitis involving the nasal planum, bridge of nose and periocular skin with concurrent respiratory signs. Very similar with those of a cat with sporotrichosis with lesion extension to the nasal sinus which causes secondary respiratory dyspnoea. Image courtesy of Dr. Francesco Albanese

(4.2%) and treatment period averaging from four to 5 months. Common observed adverse reactions were hyporexia, lethargy, weight loss, vomiting and diarrhoea plus an increase in the liver enzyme alanine transaminase. No signs of iodism (lacrimation, salivation, coughing, facial swelling, tachycardia) nor thyroid hormone abnormalities were observed in this study [38]. However, due to its low cost, sodium or potassium iodide is still often used either singularly or in conjunction with azole antifungals to treat sporotrichosis [24, 38–40].

Azoles, such as ketoconazole and itraconazole, currently constitute the cornerstone therapy for sporotrichosis in companion animals, especially in the cat and dog where the antifungal inhibits the synthesis of ergosterol in cell wall of *Sporothrix schenckii* sensu *lato*. Itraconazoles' anti-inflammatory and immunomodulatory capabilities are well documented, where it inhibits neutrophil chemotaxis and movement and reduces eosinophilic airway inflammation, and suppression of T lymphocytes has allowed itraconazole to be incorporated for the treatment of numerous human conditions such as palmoplantar pustulosis, allergic bronchopulmonary aspergillosis and mycosis fungoides [41, 42]. In veterinary medicine, itraconazole is favoured over ketoconazole as the latter is commonly associated with higher rate of adverse reactions such a vomiting, hepatic dysfunction and altered cortisol metabolism. Itraconazole at 5–10 mg/kg has been used successfully to treat feline sporotrichosis, with maximum plasma concentration of 0.7 ± 0.14 mg/L achieved with a 5-mg/kg oral dosing in the cat [43]. Based on the updated Clinical and Laboratory Standards Institute (CLSI) reference method for broth dilution antifungal susceptibility testing of filamentous fungi document M38-A2, the minimum inhibitory concentration (MIC) of *S. brasiliensis*, *S. s.* sensu stricto, *S. globosa* and *S. pallida* isolates from humans,

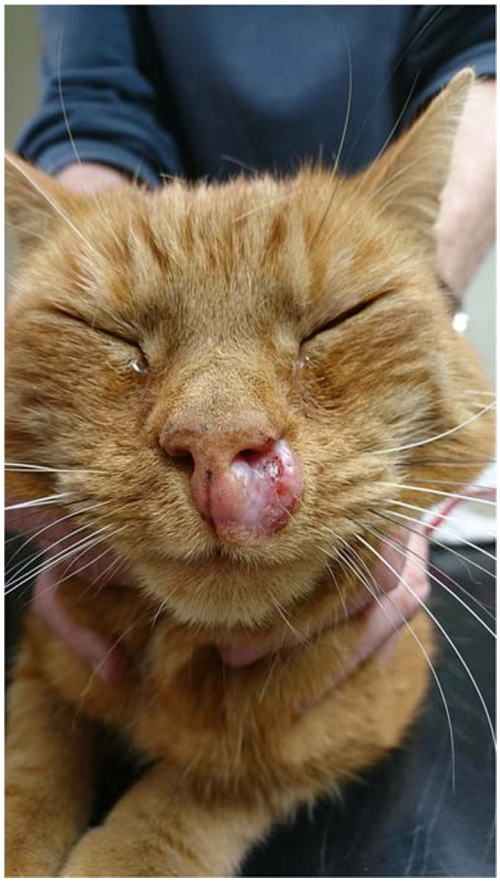

Fig. 13 A cat with an erosive and ulcerative nodular lesion at the left perinasal orifice caused by M*ycobacterium microti* which is clinically very similar with sporotrichosis. Image courtesy of Prof. Danielle Gunn-Moore

canines and felines to various commonly used antifungals is presented in Table 1 [3, 7, 8, 44–49]. When compared between species, it would suggest that *S. brasiliensis* and *S. s.* sensu stricto are more susceptible to itraconazole and ketoconazole, whereas *S. globosa*, *S. luriei* and *S. pallida* display low susceptibility towards these antifungal agents. A common observation among attending veterinarians in Malaysia treating feline sporotrichosis is the observation of cases refractory to treatment with itraconazole and observations such as these are validated by the existence of isolates with MIC towards itraconazole > 4 mg/L which is the putative breakpoint for this fungus [3, 39]. Recently, higher dosages of itraconazole and/or its combination with other antifungals has been explored to treat these refractory cases but this increases the risk of adverse reactions on the feline patient when exposed to high dosages of antifungal drugs for such a protracted period of time [39, 50, 51]. When MIC's are compared between species and different geographical regions, the lowly susceptible clonal strain of *S. s.* sensu stricto found in Malaysia compared with other parts of the world is apparent. Despite not being thermotolerant and its inability to cause systemic spread, the lowly susceptibility of the clonal strain in Malaysia towards

Table 1 Parameters of susceptibilities of *Sporothrix* spp. in its mycelial phase to antifungal agent in various species

Sporothrix spp.	Source	Origin	n	ITZ	KTZ	FLC	TRB	Amp B	VRC	CAS	Reference
S. brasiliensis	Feline	Brazil	48	0.77 [§]	0.27[§]	182[§]		0.9[§]	20.16[§]	10.37[§]	Brilhante et al. [46]
	Feline	Brazil	1	0.25	0.5	64	0.25	0.5	8	16	Oliveira et al. [48]
	Canine	Brazil	1	0.5	0.25		0.06	4.0			Viana et al. [52]
	Canine	Brazil	1	0.5	0.5		0.06	4.0			Viana et al. [52]
	Human	Brazil	23	0.36[§]	0.16[§]	56.7[§]	0.06[§]	1.03[§]	6.1[§]		Ottonelli Stopiglia [47]
S. s. sensu stricto	Feline	Brazil	6	0.14[§]	0.26[§]	90.5[§]	0.14[§]	0.08[§]	5.66[§]	11.31[§]	Oliveira et al. [48]
	Feline	Malaysia	44	1.3[§]	0.92[§]	> 256*[§]	2.85[§]	9.8*[§]			Han et al. [3]
	Human	Brazil	61	0.42[§]	0.1[§]	57.7[§]	0.05[§]	1.06[§]	8.46[§]		Ottonelli Stopiglia [47]
	Human	Brazil	31	0.261[§]	0.37[§]	87.52[§]	0.12[§]	0.34[§]	6.39[§]	25.58[§]	Oliveira et al. [48]
	Human	Brazil	1	16	4	> 64	0.25	8	> 16		Vettorato [51]
	Human	Iran	5	0.76[§]		> 64[§]	0.38[§]	3.03[§]	> 16[§]		Mahmoudi et al. [49]
S. globosa	Feline	Japan	1	3.0*	1.0*			> 32*	> 32*		Kano [4]**
	Human	Brazil	4	0.83[§]	0.15[§]	53.8[§]	0.03[§]	1[§]	11.3[§]		Ottonelli Stopiglia [47]
	Human	Iran	4	8[§]		> 64[§]	1.68[§]	5.66[§]	> 16[§]		Mahmoudi et al. [49]
S. luriei	Dog	Brazil	1	32	4	64	0.25	5	2	32	Oliveira et al. [48]
S. pallida	Feline	Australia	1	1		64		4	2	> 8	Thompson et al. [7]
	Human	USA	1	> 16		> 256			8	4	Morrison et al. [50]

[*] E-test

[**] Personal communication

[§] Geometric mean

commonly used veterinary antifungals severely limits the options available to the veterinarian to treat this disease. It can be surmised that *Sporothrix schenckii* sensu *lato* generally displays low susceptibility towards fluconazole, voriconazole and caspofungin but is sensitive to a varying degree to itraconazole, ketoconazole and clotrimazole, a common antifungal agent incorporated in many veterinary-medicated shampoo, sprays and mousses [52]. This suggest that topical application containing clotrimazole should be considered for the patient on top of systemic medication. Results from Table 1 also suggest that while *S. brasiliensis* may be the most virulent species for mammals due to its thermotolerability, less inherently virulent, non-thermotolerant species such as *S. globosa*, *S. luriei* and *S. pallida* exhibits low susceptibility to many antifungal classes compared with *S. brasiliensis*, which presents a different set of problems when attempting to treat infections from these species.

Terbinafine, a fungicide allylamine which inhibits the synthesis of ergosterol in the *Sporothrix schenckii* spp. cell wall, is another systemic antifungal therapeutic option for felines with sporotrichosis. Although it is not yet registered for the use in companion animals, terbinafine at the dosage of 30–40 mg/kg administered once a day has been utilized for the treatment of feline sporotrichosis [24]. Despite reports of successful treatment of human and canine sporotrichosis with terbinafine, its success in its incorporation for the treatment for feline sporotrichosis is still inconclusive [53]. The recent description of the protective effects of pyomelanin and eumelanin, both pigments synthesized by *S. brasiliensis* and *S. s.* sensu stricto that serves to protect the fungi against the antifungal terbinafine, may partially explain the reason why in vitro results may not necessarily correlates with in vivo response when patients were treated with this antifungal [54]. Results in Table 1 suggest that *S. brasiliensis* and *S. globosa* display susceptibility towards terbinafine but not for *S. s.* sensu stricto isolates particularly from Malaysia and *S. globosa* from Iran.

The application of amphotericin B has also been met with issues of toxicity, high cost and adverse reactions such as localized sterile abscess formation from intralesional injections [55]. Intralesional injections of amphotericin B with concurrent oral itraconazole for the treatment of sporotrichosis in cats has been described in a few publications. In a review of 26 cats with sporotrichosis treated with amphotericin B and oral itraconazole, 72.7% achieved clinical cure but only to recur in 27.3% of these patients [55, 56]. Current susceptibility studies suggest that *Sporothrix* spp. generally displays low susceptibility towards this antifungal and only intralesional injections would be able to achieve the MIC required to supress the growth of this fungus. Localized heat therapy is used as the fungus does not grow at temperature above 40 °C. This treatment modality has been met with issues of practicality and perhaps welfare concerns in its application on cats. As it is impossible to convince an animal patient to remain still for

Fig. 14 Post-healing ear tip deformity due to extensive tissue necrosis from infection

extended period of time for localized heat therapy to work, and it is also inhumane to expose patients to extreme heat, and thus, heat therapy has not been pursued as a viable treatment option in the cat [57, 58]. Cryosurgery, used in conjunction with itraconazole, has been used successfully to treat and cure 11 of 13 cats with sporotrichosis, with treatment lasting 3–16 months and a median of 8 months [59]. Surgical resection is possible for localized singular lesions but practical for generalized, disseminated forms [24].

During treatment follow-up reviews, it is imperative that the persistence of granuloma, especially those in the ear pinnae of cats, is assessed. As these resolving granulomas are visually and tactile wise indistinguishable to normal adjacent healthy tissue under normal room lighting, these granulomas may be better visualized when held against a bright light source. Any premature cessation of antifungal therapy before the complete resolution of granuloma will certainly lead to a relapse of disease. It is also not uncommon for ear tips to suffer from post-healing deformity which may jeopardise the aesthetic appearance of the patient (Fig. 14). Treatment is continued for 1 month beyond the resolution of all skin lesions and granulomas before a declaration of mycological cure. In a recent survey of 104 veterinarians in Malaysia, up to 12% of veterinarians in this survey have personally been infected with *Sporothrix* spp., with 58% of them observing clinical lesions suggestive of sporotrichosis on the owners of cats with the same disease (Han, unpublished data). Thus, it is also not surprising that the risk of zoonotic transmission was the most significant factor the veterinarian considers during treatment and the reason why some veterinarians may have reservations when presented with a cat with lesions suggestive of sporotrichosis. This highlights the importance of continuing education among veterinarians in order to reinforce personal hygiene and preventative measures in order to prevent zoonotic transmission.

Conclusion

The prognosis of feline sporotrichosis in Malaysia and by extension, Asia, remains guarded to poor due to persistent issues of cost, protracted time to treat, risk of zoonotic transmission and potential adverse reactions of antifungals when administered on a long-term basis. Not only in terms of the risk of zoonotic transmission, the current repertoire of commonly used registered veterinary antifungals consists of only itraconazole which is inadequate to address the issue of low fungal susceptibility. Future resources could be allocated for a larger scale epidemiological study of feline and canine sporotrichosis in Asia or the establishment of a pan-Asia sporotrichosis research centre. Regular seminars and workshops for veterinarians and pet owners for disease prevention should also be encouraged to highlight the importance of cats as disease propagators and the importance of early neutering to reduce inter-animal aggression to prevent inter-cat transmission.

Compliance with ethical standards

Conflict of interest The authors declare that there are no conflict of interest.

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