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Dermatophytosis of the Four-toed Hedgehog Caused by *Trichophyton erinacei*

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Abstract : *Trichophyton erinacei* is a dermatophyte pathogen that infects both humans and hedgehogs. A two-month old female four-toed hedgehog presented to the Chonbuk Animal Medical Center with pruritus, excoriation and crust on her face for ten days. The owner of the hedgehog also exhibited the clinical signs of scaly erythema with fine vesicles on her neck. A presumptive diagnosis of dermatophytosis was made based on the results of an acetate tape preparation in which hyphae and chains of arthroconidia were observed. The crusts from the lesions were then cultured on Sabouraud Dextrose Agar for identification. After 10 days of incubation, downy colored colonies that had a central umbo with a white granular surface and a yellow pigment ring in the reverse were observed. Microscopic analysis revealed the presence of numerous teardrop shaped microconidia singly attached to the sides of the hyphae. In addition, 2-6 roomed macroconidia that were somewhat irregular in shape and size were present, and abundant intermediate sized spores were observed between the micro and macro conidia. To confirm that the culture was *T. erinacei*, the internal transcribed spacer region of the 5.8S phase of the ribosomal RNA gene (ITS1-5.8S-ITS2 rDNA) was amplified by PCR and then sequenced. A 679-base pair fragment of DNA was then compared with sequences in GenBank and found to be 99% homologous with sequences of *T. erinacei* (Z97997 and Z97996.The clinical signs were resolved after four weeks of treatment with oral and topical ketoconazole and chlorhexidine. To the best of our knowledge, this represents the first case of *T. erinacei* isolated from a four-toed hedgehog in Korea.

Key words : *Trichophyton erinacei*, hedgehog, dermatophytosis, PCR, ITS1 rRNA gene

Introduction

Recently, the species of animals being kept as pets in Korea has diversified and many rare species have been imported from abroad. Concurrently, the transmission of diseases from these animals, which include hamsters, rabbits, turtles and hedgehogs, to humans has also increased. However, pet owners and non-veterinary healthcare providers are generally not knowledgeable about the potential diseases caused by these animals or the possibility of the transmission of these diseases to humans. In this study, the isolation and identification of *Trichophyton erinacei*, which is a zoonotic that effects both hedgehogs and humans, from a four- toed hedgehog is described.

Hedgehogs are small, spiny-coated insectivores that have been gaining popularity as exotic pets (7). Although several species exist, the 2 that are most commonly seen as pets are the European hedgehog, *Erinaceus europaeus*, and the African pygmy hedgehog, *Atelerix albiventris* (7). The African pygmy hedgehog is generally smaller than other species of hedgehogs and is noted for the absence of the first toe of the hind leg, therefore it is also known as a "four-toed" hedgehog. Despite the fact that this variety of hedgehog cannot truly be domesticated, it has nonetheless become a popular household pet in Korea.

T. erinacei was formerly classified as *Trichophyton mentagrophytes* var *erinacei*, however, it has been reclassified as *T erinacei* due to morphological and biochemical differences from other *T mentagrophytes* (11). *T. erinacei* is the dermatophyte most commonly isolated from hedgehogs, although *Microsporum spp*. has also been reported (3). T erinacei have been reported in many regions throughout the world, including New Zealand (9), Africa (2), Europe (4), America (12), and recently, Japan (10,14). To the best of our knowledge, this report represents the first known finding of *T erinacei* infection in Korea, as well as the first isolation of *T erinacei* from a household hedgehog.

Case report

A two-month old female four-toed hedgehog weighing 100 g bred in an indoor urban house in Jeonju city presented at Chonbuk Animal Medical Center. At the time that she presented, she had a 10 day history of pruritus, excoriation and crusts on her face. The owner of the hedgehog had purchased the animal over the internet approximately 1 month prior to admission. Although the natural habitat of the hedgehog was confirmed to be Africa, the details of how it was brought to Korea could not be determined. The owner also had another

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hedgehog that had been kept in a separate indoor cage and was clinically healthy.

Upon physical examination the hedgehog was found to have excoriation with severe crusts that felt hard on her face (Fig 1). No lesions were found except for those on her face. The owner of the hedgehog also exhibited clinical signs of scaly erythema with fine vesicles on her neck. The owner had no history of direct contact with the hedgehog on her neck, but did have a history of indirect contact through her necklace. Samples of the crusts collected using acetate tape revealed the presence of small numbers of hyphae and chains of arthroconidia (Fig 2), therefore a presumptive diagnosis of dermatophytosis was made. The crusts were then cultured on Sabouraud Dextrose Agar (SDA) for identification. After 10 days of incubation, powdery colonies with an ivory-white surface were observed. The center of the colonies was downy, elevated slightly and showed a yellow pigment on the reverse side. Upon microscopic analysis, tear drop shaped elongated microconidia attached to the sides of the hyphae were observed. The macroconidia were somewhat 2-6 septations and irregular in shape and size. In addition, abundant intermediate sized spores were observed between the micro and macro conidia (Fig 3).

DNA was extracted from the colonies that were grown on the Sabouraud Dextrose Agar and extracted using a previously described method (8). The internal transcribed spacer region of the 5.8S phase of the ribosomal RNA gene was then amplified by nested PCR using the ITS5 primer (5'-GGA AGT AAA AGT CGT AAS AAG G-3') and the ITS4 primer (5'-TCC TCC GCT TAT TGA TAT GC-3'), followed by nested PCR using the ITS1 primer (5'-TCC GTA GGT GAA CCT GCG G-3') and the ITS4 primer (14). Template DNA (3 μl) was added to 47 μl mixture comprised of 36.7 μl of sterile ultrapure water, 5 μl of 10 × PCR buffer, 2 μl of deoxynucleotide triphosphates (dNTPs) mixture, 1.5 μl of each primer (10 pmol/μl) and 0.3 μl of Taq polymerase (5 U/μl, iNtRON, Korea). This mixture was then subjected to the following conditions: initial denaturation for 5 min at 94°C, followed by 25 cycles of 1 min at 94°C, 30 sec at 55°C, 1 min at 72°C. Next, the PCR product was electrophoresed in 1.5% agarose gel, stained with ethidium bromide and photographed using a still video documentation system (Gel Doc 2000, Bio Rad, USA) (Fig 4).

To confirm the nucleotide sequence, PCR products were cloned and then the cloned DNA was sequenced using an automatic sequencer (ABI prism ⓡ 377, Applied Biosystem, USA), which resulted in a 679 bp sequence. A nucleotide sequence homology search revealed that the sequence was 99% homologous with the partial sequence of the ITS1-5.8S-ITS2 rRNA gene of *T. erinacei* (accession numbers Z97996 and Z97997).

The lesion on the hedgehog gradually decreased in size and was completely resolved after 4 weeks of treatment with ketoconazole (30 mg/kg BID) and topical chlorhexidine. The lesion on the owner was resolved using topical antifungal treatment. However, we did not attempt to identify the cause of the lesion on the owner.

Fig 1. Clinical findings of the hedgehog. Note, the excoriation (arrow) and severe crusts (arrow head) on her face.

Fig 2. Acetate tape sampling of the lesion. Hyphae (arrow) and chains of arthroconidia (arrow heads) were observed. (Hematoxyllin and eosin, × 1000)

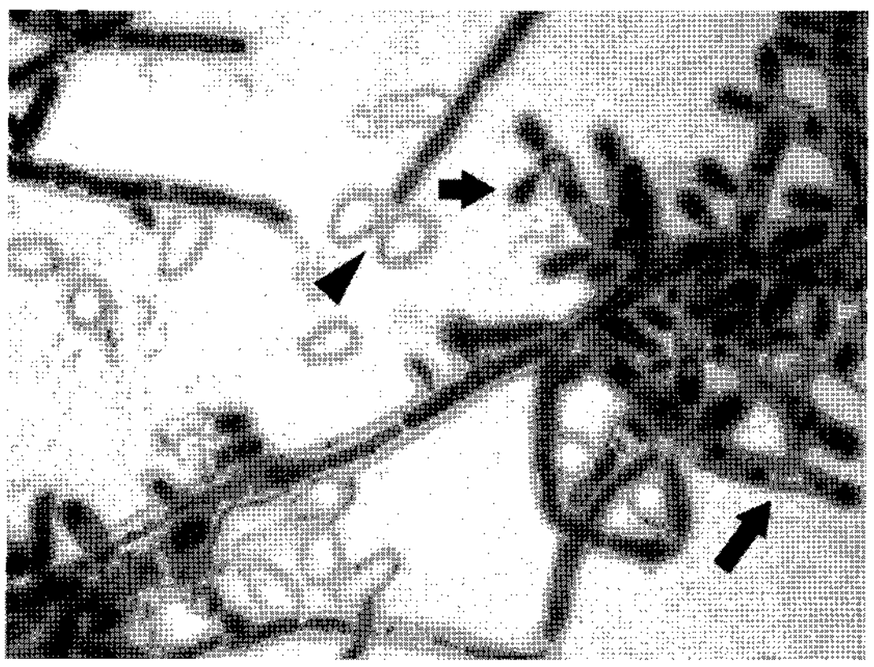

Fig 3. Microscopic findings of the colonies. Tear drop shaped elongated microconidia (short arrow), with irregular shaped of 2-6 septations of Macroconidia (long arrow), as well as intermediate sized spores (arrow head) were observed. (New Methylene Blue × 1000)

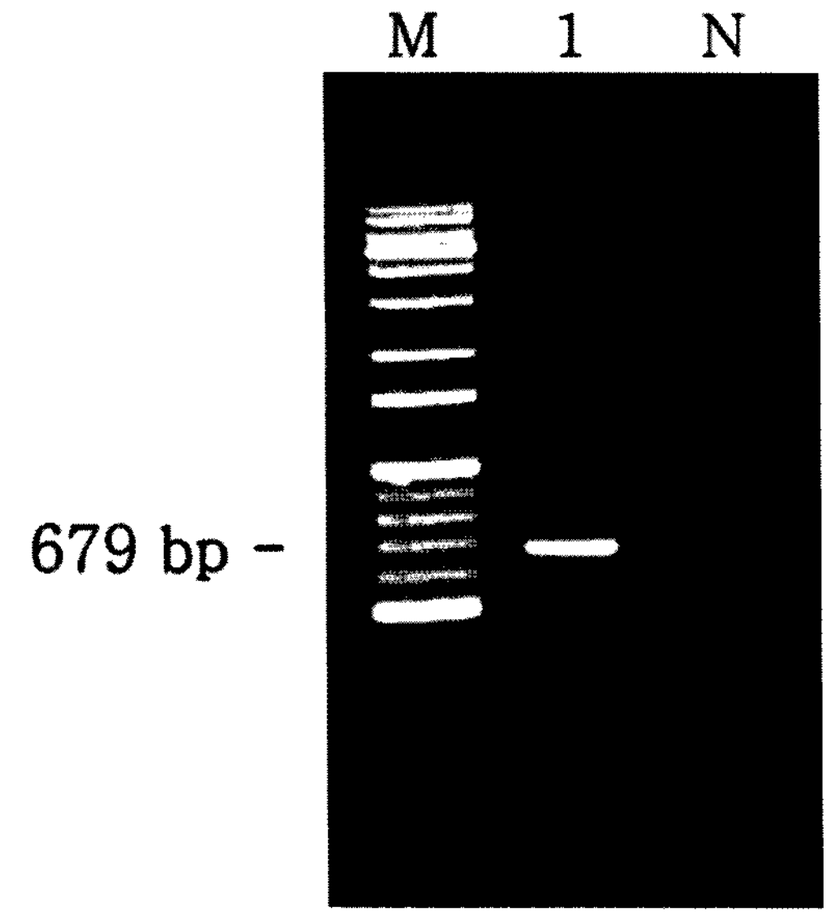

Fig 4. Nested PCR detection of *T. erinacei*. A 679-base pair fragment of DNA was amplified. (M; 1kb plus DNA ladder, lane 1; sample, N; negative control)

Discussion

Although dermatophyte pathogens have been isolated from many domestic and companion animals in Korea, this is the first report of *T. erinacei* being isolated from a pet. Marples *et al.* (9) have reported isolates of *T. mentagrophytes* var. *erinacei* from hedgehogs and people who came in contact with the animals in New Zealand. In their study, they noted several differences between the isolated fungus and other varieties of *T. mentagrophytes*, including the presence of yellow pigmented colonies on the reverse, elongated microconidia along sides of the hyphae, abundant intermediate spores between the micro- and macroconidia and few spiral bodies. Based on their finding, Smith *et al.* (13) proposed that the isolated fungus should be classified as a separate species.

Many cases of *T. erinacei* isolated from the Western European hedgehog (*Erinaceus europaeus*) have been reported. In addition, isolation of *T. erinacei* from the four-toed hedgehog (*Atelerix albivenris*) was reported in Kenya, which is the natural habitat of the hedgehog, as well as in America (12) and Japan (10,14). Many four-toed hedgehogs are also being imported into Japan from Africa as household pets. According to several studies, 44.7% of wild hedgehogs in New Zealand (13) and 38.9 % of pet hedgehogs in Japan (15) are infected with *T erinacei*, and the distribution of *T erinacei* is presumably coextensive with that of the hedgehogs. Therefore, it is likely that many hedgehogs in pet shops and households in Korea are infected with *T erinacei*.

Clinically, infected hedgehog shows scaly, dry skin with bald patches and spine loss. *T. erinacei* is most commonly isolated from the quills and unberbelly (3), although the only clinical signs observed in this case were on the face. Hedgehogs also can be asymptomatic carriers, therefore it may transmit the disease to another animal or to humans without exhibiting any visible signs of infection, or without the owner's (3). Several studies documenting the transmission of *T erinacei* from hedgehogs to humans, as well as to canines and felines (1). In humans, *T erinacei* cause an extremely inflammatory and pruritic eruption (9,5,10).

English *et al.* (4) reported that both direct and indirect contact with hedgehogs can be routes of *T erinacei* infection in humans, and that *T erinacei* could survive in hedgehog nests for up to one year under dry conditions. This suggests that, in addition to direct contact with infected hedgehogs, contact with infected material may also result in transmission of the disease, therefore, hedgehog owners should be informed about all possible routes of infection.

To ensure proper diagnosis, it is important to have a reliable method for the identification of dermatophyte species. Several methods including standard biochemical tests, microscopy, colony characteristics and mating tests have been conventionally used to identify dermatophyte species, however, these methods are costly, time- consuming, and require special skills (6). As reported previously, the sequence of the ITS1 rRNA gene is useful for resolving phylogenetic relationships between closely related fungi as well as for species identification (8). In this study, we confirmed the nucleotide sequence polymorphism of *T erinacei* through gene cloning, which revealed that the sequence of the isolate was 99% homologous with that of a registered *T erinacei*. This allowed discrimination between *T. erinacei* and other *Trichophyton* spp., indicating that PCR detection and sequence analysis can be a highly reliable molecular method for identification of this organism.

In conclusion, because the importation of various exotic pets is increasing, the present study further demonstrates the influx of pathogenic fungi that did not previously exist in Korea and indicates that this trend is likely to continue. Veterinarians should be aware of this trend and ensure that they provide the proper information to clients so that they fully understand the disease and zoonotic potential of their pets.

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