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Histopathological Findings of *Trichophyton rubrum* Infection in *Ex vivo* Human Skin

Hyun Ji Lee, Chihyeon Sohng, Jun Young Kim, Kyung Duck Park, Seok-Jong Lee and Weon Ju Lee†

Department of Dermatology, School of Medicine, Kyungpook National University, Kyungpook National University Hospital, Daegu, Korea

Trichophyton rubrum (*T. rubrum*) is the most usual dermatophyte that is responsible for dermatophytosis in humans[1]. A classic characteristic of dermatophytes is being keratinophilic. Thus, they occupy keratinized structures, including the stratum corneum of the skin, hairs, and nails. Occasionally, *T. rubrum* occupies the deeper skin or distant internal organ in immunosuppressed patients[2,3]. It is unfortunate that its pathogenic mechanism of invasion into the stratum corneum and dermis is not still totally understood. Different models, such as the animal model, stripped sheets of the stratum corneum, nail plates, monolayer cell culture model, or reconstructed human epidermis, were utilized for the examination of the mechanism of dermatophyte infection[4-8]. Even though they had a few limitations to imitate dermatophyte infections in humans, they can partly exhibit the pathogenic mechanism of dermatophyte infection. In our study, we investigated the histopathological characteristics in *T. rubrum* infection with the use of *ex vivo* human skin. *Trichophyton rubrum* was cultured for 2 weeks at 24℃ on Sabouraud dextrose agar. It was transferred to 10 *ex vivo* skin specimens which were foreskin acquired from circumcision. The *ex vivo* skin specimens were kept on the Sabouraud dextrose agar at 24℃ for 1 week. Afterward, histopathological examination was performed using the periodic acid-Schiff-diastase (PAS-D) stain under a light microscope. In the examination, slender septate hyphae with several arthroconidia were found in the stratum corneum (Fig. 1A, 1B). *Trichophyton rubrum* often generates arthroconidia *in vivo*. Arthroconidia are involved in pathogenesis and function as a source of infection. Thicker septate hyphae and chlamydospore were found in the lower epidermis (Fig. 1B, 2A). Thicker septate hyphae and chlamydospore were also shown in the dermis (Fig. 1B, 2A, 2B). Chlamydospore is the life stage which survives in unfavorable conditions. Corzo-León et al.[9] performed a study with *ex vivo* human skin placed on Dulbecco's Modified Eagle Medium. They exhibited long hyphae in the *ex vivo* skin surface 10 days following *T. rubrum* infection. Hyphae and arthroconidia of *T. rubrum* were much more demonstrated in *ex vivo* human skin in our study than in Corzo-León et al's. Liang et al.[8] introduced the reconstructed human epidermis for *T. rubrum* infection model. In the said study, conidia and hyphae of *T. rubrum* were seen in the stratum corneum of the reconstructed human epidermis 4 days following its inoculation. Apart from this, infection with much more conidia of *T. rubrum* displayed a full epidermal invasion beyond the superficial keratinous layer. Ho et al.[4] examined *T. rubrum* infection with the explanted porcine skin model. In the study, extended duration of infection in the skin led to luxurious growth and invasion of the dermis. The conditions might be the result of no active immune system that would restrain fungal growth, similar to our study. Invasive dermatophytoses happen more frequently in the immunocompromised host than in the healthy person. *Trichophyton rubrum* accounts for the majority of invasive fungal infections in immunosuppressed patients. *Trichophyton rubrum* in superficial dermatophytoses is confined in the stratum corneum, demon-

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†Corresponding: Weon Ju Lee, Department of Dermatology, Kyungpook National University Hospital, 130 Dongduk-ro, Jung-gu, Daegu, 41944, Korea.
Phone: +82-53-420-5838, Fax: +82-53-426-0770, e-mail: weonju@knu.ac.kr

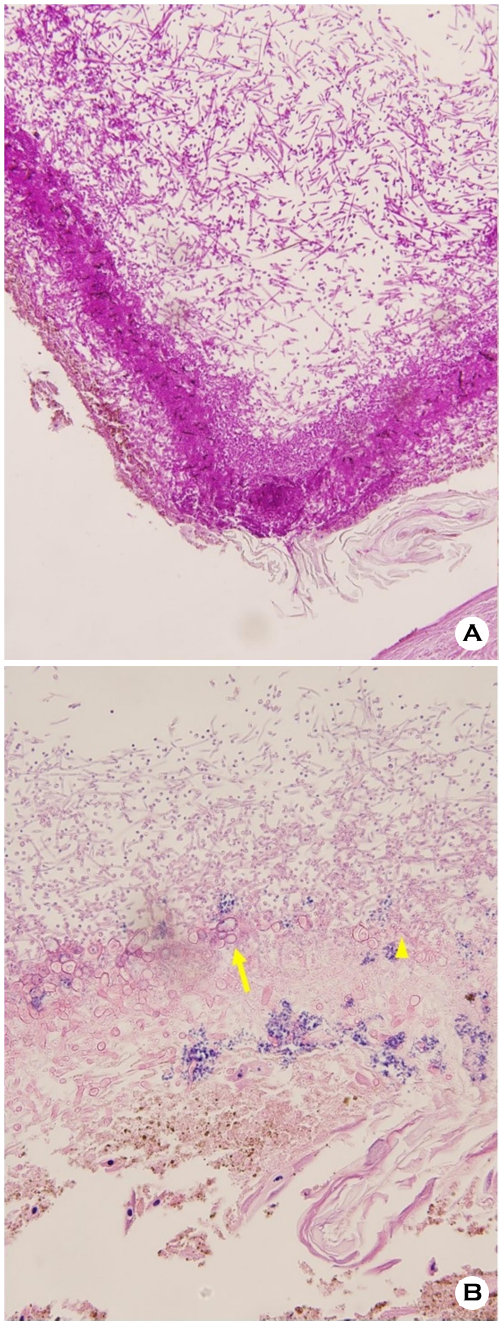

Fig. 1. (A) Slender pinkish septate hyphae with several arthroconidia in the stratum corneum (PAS-D, x200) (B) Slender pinkish septate hyphae with several arthroconidia (arrow head) in the stratum corneum and thicker septate hyphae and chlamydospore-like structures (arrow) in the lower epidermis and upper dermis (PAS-D, x400)

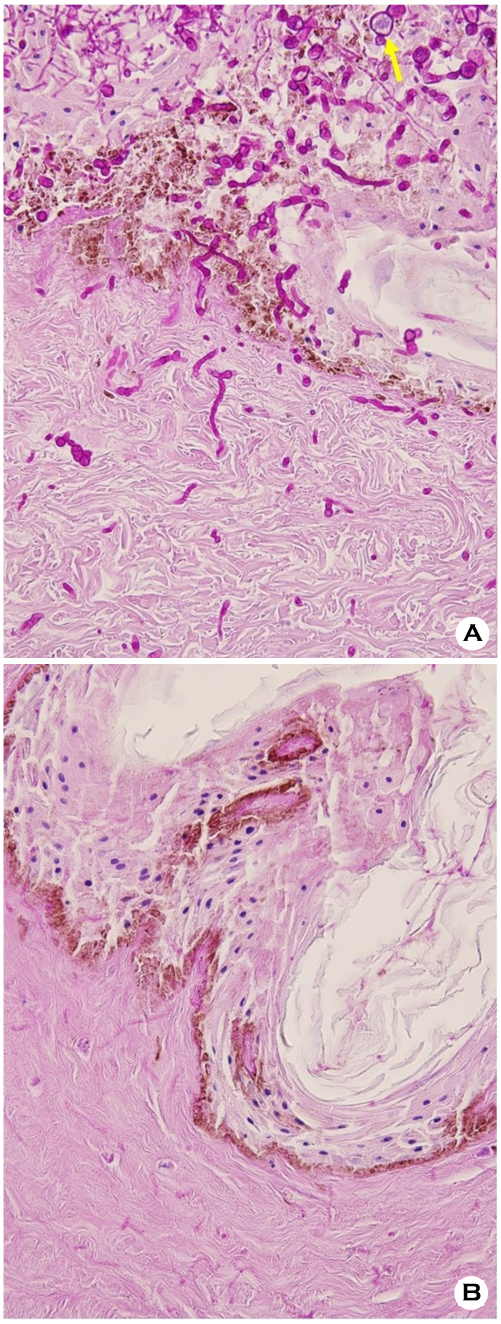

Fig. 2. (A) Thicker septate hyphae and chlamydospore-like structures (arrow) in the lower epidermis and thicker and shorter septate hyphae in the upper dermis (PAS-D, x400) (B) Thicker and shorter septate hyphae in the upper dermis (PAS-D, x400)

strating a thin septate hyphae fragment in PAS staining. Nonetheless, it is possible for *T. rubrum* to show atypical and bizarre hyphae in the dermis in invasive dermatophytoses[5]. So, these findings make suitable diagnosis hard. Our study exhibited an atypical morphology of *T. rubrum*, such as

chlamydospores and thicker hyphae, in the lower epidermis and dermis. These results will allow the recognition of the possibility of appearance changes of *T. rubrum* in invasive dermatophytoses.

Key Words: Arthroconidia, Chlamydospore, Dermatophytosis, *Ex vivo* human skin, Histopathology, *Trichophyton rubrum*

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CONFLICT OF INTEREST

In relation to this article, we declare that there is no conflict of interest.

ORCID

Hyun Ji Lee: 0000-0002-4222-1835
Chihyeon Sohng: 0000-0002-1452-7896
Jun Young Kim: 0000-0002-2999-1018
Kyung Duck Park: 0000-0002-6067-7262
Seok-Jong Lee: 0000-0002-6131-632X
Weon Ju Lee: 0000-0001-5708-1305

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