

Epidemiological and Mycological Characteristics of Teenagers with Tinea Capitis in Southeastern Korea: *Trichophyton tonsurans* as the Main Causative Fungus in Recent 10 Years

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Background: Tinea capitis is a contagious fungal infection that occurs predominantly in childhood. Although its incidence has declined, its epidemiological and mycological characteristics are continue to evolve.

Objective: To assess changes in the epidemiological and mycological characteristics of tinea capitis in teenage patients in Southeastern Korea.

Methods: We retrospectively investigated epidemiological and mycological characteristics of 202 teenage patients with tinea capitis who visited Kyungpook National University Hospital and the Catholic Skin Disease Clinic from 1989-2018.

Results: Of 202 patients, 177 patients showed KOH-positivity. Dermatophytes were cultured from 157 patients. The annual incidence of tinea capitis ranged from 0 to 30 between 1989 and 2018. Of 202 patients, 153 patients (75.74%) were male and 49 patients (24.26%) were female. The ratio of male to female was 1:0.32. For seasonal distribution, 78 patients (38.61%) visited our hospital in winter, 59 patients (29.21%) visited in spring, 35 patients (17.33%) visited in fall, and 30 patients (14.85%) visited in summer. *Microsporum canis* was the most common dermatophyte (44.06%) isolated from tinea capitis. *Trichophyton tonsurans* was the second most common dermatophyte (26.73%). For inhabitancy distribution, 151 patients (74.75%) lived in urban areas and 51 (25.25%) lived in rural areas.

Conclusion: The epidemiological characteristics of teenage patients with tinea capitis were distinct from those of adults in annual incidence, sexual distribution and isolated dermatophytes. *Trichophyton tonsurans* was the main causative organism of tinea capitis in recent 10 years. These results are useful for the targeted treatment and prevention of tinea capitis.

Key Words: Korea, Teenage, Tinea capitis, *Trichophyton tonsurans*

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INTRODUCTION

Tinea capitis is one of several dermatophytoses caused by dermatophyte fungi and is highly contagious in children¹. *Trichophyton (T.) ferrugineum* was the most common dermatophyte in Korean tinea capitis in the 1960s². However, *Microsporum (M.) canis* has been prevalent since the 1970s³. In recent periods, *T. tonsurans* was reported as a causative fungus of tinea capitis^{4,5}. Indeed, *T. tonsurans* has been found to be the main causative fungus of tinea capitis in teenagers⁶. *T. tonsurans* was thought to be originally imported from athletes during the international game⁷. Tinea capitis caused by *T. tonsurans* clinically manifests as scaly patches with black dots on the scalp. Here, we retrospectively investigated and analyzed changes in the epidemiological and mycological characteristics of tinea capitis in teenage patients in Southeastern Korea.

MATERIALS AND METHODS

1. Patients

To analyze the epidemiological and mycological characteristics of patients with tinea capitis, we retrospectively reviewed medical records and identified a total 1,254 patients with tinea capitis who visited Kyungpook National University Hospital and Catholic Skin Disease Clinic from 1989-2018. Only teenage (ages 10-19) patients were included: a total of 202 teenage patients were identified. We investigated annual incidence, sexual distribution, seasonal distribution, isolated dermatophytes, and residence of each patient. To analyze changes over time, patients were divided into three groups according to visit date: Group A: 1989-1998, Group B: 1999-2008, Group C: 2009-2018.

2. Diagnosis of *Trichophyton* infection

Scales and hairs were obtained from patients' scalps for fungal examination, and 15% potassium hydroxide (KOH) examination was performed. Of 202 patients, 177 (87.62%) showed KOH-positivity. Causative dermatophytes were isolated from fungal culture using potato dextrose agar corn meal Tween 80 media. The culture media were stored at 24~26°C and examined after 2~4 weeks. Dermatophytes were successfully cultured from 157 of 202 patients. In addition, microscopic examination was performed with lactophenol cotton blue stain to identify filamentous fungi with conidia. A Wood lamp was also used to detect fluorescent fungal elements.

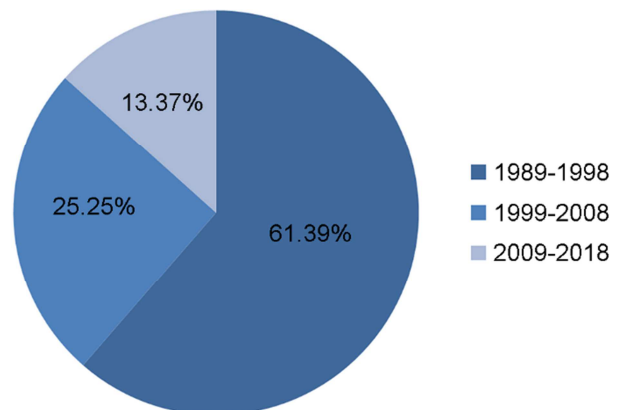


Fig. 1. Incidence rate of teenage tinea capitis according to a period of time was shown as following: Of 202 teenage tinea capitis patients from 1989 to 1998, 124 (61.39%) were in between 1989 and 1998, 51 (25.25%) were in between 1999 and 2008, and 27 (13.37%) were in between 2009 and 2018.

3. Ethics statements

This study was conducted after approval by the Institutional Review Board of Kyungpook National University Hospital (IRB No. 2019-03-014). Informed patient consent was waived by the board.

RESULTS

1. Incidence

Of 1254 patients diagnosed with tinea capitis between 1989 and 2018, 202 teenage patients (16.11%) were identified. Of 780 patients with tinea capitis from 1989-1998, 124 (15.90%) were teenagers (Group A). Of 271 patients diagnosed with tinea capitis from 1999-2008, 51 (18.82%) were teenagers (Group B). Of 203 patients diagnosed with tinea capitis from 2009-2018, 27 (13.30%) were teenagers (Group C). Of 202 teenage tinea capitis patients between 1989 and 2018, 124 (61.39%) were in Group A, 51 (25.25%) were in Group B, and 27 (13.37%) were in Group C (Fig. 1).

The annual incidence of teenage tinea capitis ranged from 0 to 30 between 1989 and 2018 (Fig. 2). The mean annual incidence of teenage tinea capitis was 12.4 in Group A, 5.1 in Group B and 2.7 in Group C. The mean annual incidence of teenage tinea capitis was 6.7 from 1989-2018. The incidence was lowest in 2007 and highest in 1989.

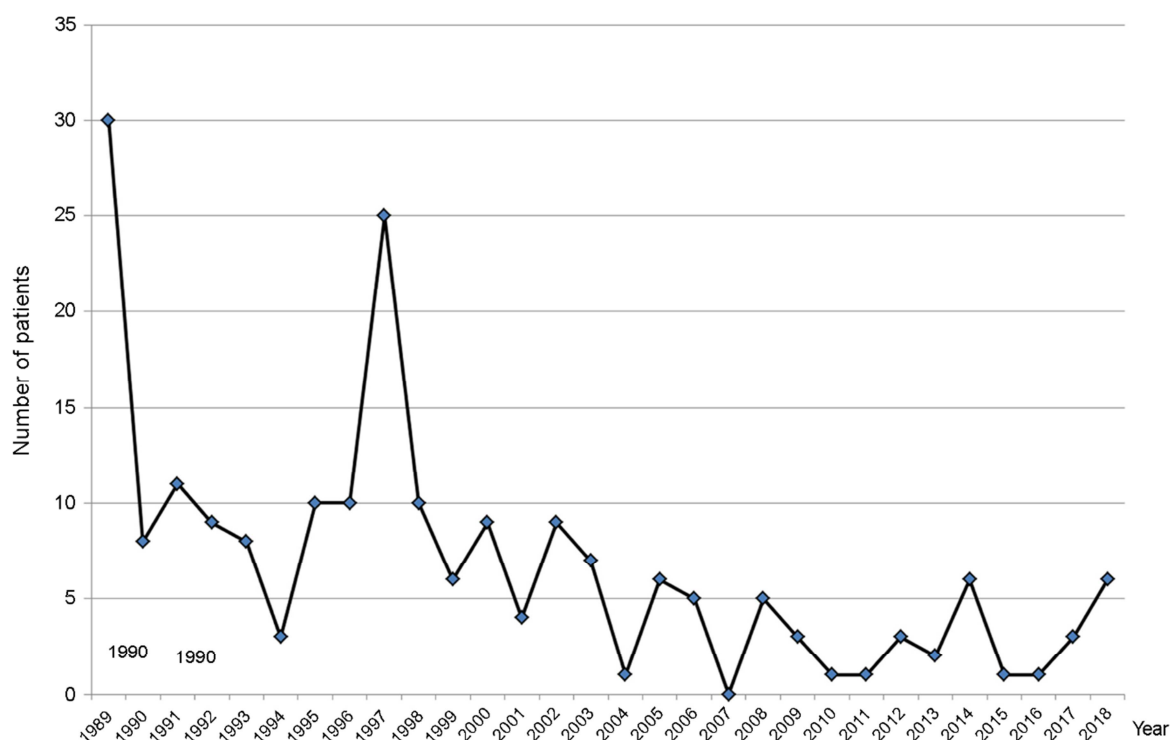


Fig. 2. Annual incidence of teenage patients with tinea capitis was highest in 1989 and lowest in 2007, showing a decreasing tendency with time.

2. Sexual distribution

Of 124 patients of Group A, 96 patients (77.42%) were male and 28 patients (22.58%) were female. The ratio of male to female was 1:0.29. Of 51 patients of Group B, 38 patients (74.51%) were male and 13 patients (25.49%) were female. The ratio of male to female was 1:0.34. Of 27 patients of Group C, 19 patients (70.37%) were male and eight patients (29.63%) were female. The ratio of male to female was 1:0.42. Of 202 patients, 153 patients (75.74%) were male and 49 patients (24.26%) were female. The ratio of male to female was 1:0.32.

3. Seasonal distribution

Of 124 patients of Group A, 48 patients (38.71%) visited our hospital in winter, 41 patients (33.06%) visited in spring, 24 patients (19.35%) visited in fall, and 11 patients (8.87%) visited in summer. Of 51 patients of Group B, 18 patients (35.29%) visited our hospital in winter, 16 patients (31.37%) visited in summer, nine patients (17.65%) visited in spring, and eight patients (15.69%) visited in fall. Of 27 patients of Group C, 12 patients (44.44%) visited our hospital in winter,

9 patients (33.33%) visited in spring, three patients (11.11%) visited in summer, and three patients (11.11%) visited in fall. Of 202 patients, 78 patients (38.61%) visited our hospital in winter, 59 patients (29.21%) visited in spring, 35 patients (17.33%) visited in fall, and 30 patients (14.85%) visited in summer (Table 1).

4. Isolation of dermatophytes

In Group A, *M. canis* was the most common dermatophyte (50.81%) isolated from tinea capitis. *T. tonsurans* was the second most common dermatophyte (21.77%). *T. rubrum* was isolated from three patients. *T. mentagrophytes*, *T. verrucosum* and *M. ferrugineum* were isolated from two patients, respectively. In Group B, *M. canis* was the most common dermatophyte (37.25%) isolated from tinea capitis. *T. tonsurans* was the second most common dermatophyte (23.53%). *T. rubrum* was isolated from three patients. *T. mentagrophytes* and *T. verrucosum* were isolated from only one patient, respectively. In Group C, *T. tonsurans* was the most common dermatophyte (55.56%) isolated from tinea capitis. *M. canis* was the second most dermatophyte (25.93%) isolated from tinea capitis. In 202 teenage patients, *M. canis* was the most

Table 1. Seasonal distribution of tinea capitis in teenage patients

Period	Season				Total
	Spring	Summer	Fall	Winter	
1989-1998	41	11	24	48	124
1999-2008	9	16	8	18	51
2009-2018	9	3	3	12	27
Total	59	30	35	78	202

Table 2. Isolation of dermatophytes in teenage patients with tinea capitis

Period	Causative fungus								Contaminant	Negative	Total
	<i>M. canis</i>	<i>T. rubrum</i>	<i>T. mentagrophytes</i>	<i>T. verrucosum</i>	<i>T. tonsurans</i>	<i>M. gypseum</i>	<i>M. ferrugineum</i>				
1989-1998	63	3	2	2	27	0	2	5	20	124	
1999-2008	19	3	1	1	12	0	0	9	6	51	
2009-2018	7	0	0	0	15	0	0	1	4	27	
Total	89	6	3	3	54	0	2	15	30	202	

M.: *Microsporum*, *T.*: *Trichophyton*

common dermatophyte (44.06%) isolated from tinea capitis. *T. tonsurans* was the second most common dermatophyte (26.73%) (Table 2).

5. Inhabitancy distribution

Of 124 patients of Group A, 88 patients (70.97%) lived in urban areas and 36 (29.03%) patients lived in rural areas. Of 51 patients of Group B, 39 patients (76.47%) lived in urban areas and 12 patients (23.53%) lived in rural areas. Of 27 patients of Group C, 24 patients (88.89%) lived in urban areas and three patients (11.11%) lived in rural areas. Of 202 teenage patients with tinea capitis, 151 patients (74.75%) lived in urban areas and 51 patients (25.25%) lived in rural areas.

6. Coexisting dermatophytosis

Tinea faciei coexisted with tinea capitis in seven patients in Group C. Tinea corporis coexisted in nine patients in Group C.

7. Clinical features

Almost all of patients in Group C presented with scaly hairless patches and/or folliculitis on the scalp. Only three patients

had kerion celsi.

8. Causative factors and underlying diseases

Of 27 patients in Group C, one had a past history of contact with a cat and two had atopic dermatitis as an underlying disease. Two patients were judoists and 13 patients were wrestlers.

9. Treatment of tinea capitis

All patients had been treated with antifungals, such as oral itraconazole and terbinafine.

DISCUSSION

T. ferrugineum was identified as a major causative fungus of Korean tinea capitis in the 1960s². *M. canis* has been the most prevalent cause of tinea capitis in Korea since the 1970s³. Starting in 1995, a nation-wide outbreak of trichophytosis gladiatorum caused by *T. tonsurans* was noted among wrestlers and judoists in Korea. Jun and Choi⁴ and Jun and Kim⁵ reported the epidemiological, clinical and mycological characteristics of trichophytosis gladiatorum caused by *T. tonsurans*

in Korean wrestlers and judoists. They found that patients with trichophytosis gladiatorum were predominantly teenagers. Tinea capitis was the most common type of dermatophytosis in these patients. It was followed by tinea corporis and tinea faciei in incidence.

Trichophytosis gladiatorum is usually found on the head, neck, and extremities. This distribution supports the notion that skin-to-skin transmission is the most common cause of dermatophytosis⁸. Wrestlers and judoists occasionally travel and board in a group setting, increasing the likelihood of trichophytosis gladiatorum outbreaks. In addition, infected players often participate in competitions without any prevention or treatment, therefore serving as a reservoir for transmission of fungal organisms to other players. Indeed, in 1995, Hradil et al.⁹ reported an outbreak of dermatophytosis caused by *T. tonsurans* in 19 Swedish wrestlers who competed against American athletes, demonstrating the possibility of international disease spread. In this study, of 27 teenage patients diagnosed with tinea capitis from 2009-2018, 15 (55.56%) were wrestlers or judoists, and *T. tonsurans* was the most frequent dermatophyte (55.56%) isolated.

likit et al.¹⁰ studied Turkish wrestling patients with trichophytosis gladiatorum. They found that the scalp was the most common site of infection and that *T. tonsurans* was the most common causative fungus. Hedayati et al.¹¹ also reported patients with trichophytosis gladiatorum in Iran. They demonstrated that the patients were teenagers with most lesions located on the trunk and head. In addition, *T. tonsurans* was isolated from all patients. Other outbreaks of tinea gladiatorum due to *T. tonsurans* have also been reported¹²⁻¹⁸.

Griseofulvin has been the treatment of choice for tinea capitis over 30 years before the advent of new antifungal agents such as terbinafine and itraconazole. Terbinafine may be a more desirable agent for tinea capitis caused by *T. tonsurans* because of shorter treatment schedule and lower recurrence rate¹⁹. Itraconazole is as effective as griseofulvin and terbinafine, and the pulsed regimen was also reported to be effective on tinea capitis²⁰⁻²². Ketoconazole is avoided in children because of hepatotoxicity and its effectiveness over griseofulvin is controversial²³. Proper treatment of dermatophytoses in athletes, especially judoists and wrestlers, is necessary to prevent future outbreaks during regular competitions and practices. The patients in our study were treated with either oral terbinafine or itraconazole.

Data from this study were extracted from the medical records of teenage patients with tinea capitis who were wrestlers, judoists or neither. We found that *M. canis* was the most common dermatophyte isolated from teenage patients with tinea capitis and that *T. tonsurans* was the second most com-

mon dermatophyte isolated from teenage patients with tinea capitis. Interestingly, *T. tonsurans* was the most common cause of tinea capitis in teenage patients in recent 10 years. Common coexisting dermatophytoses were tinea faciei and tinea corporis. Generally, we found that the incidence of tinea capitis in teenage patients decreased from 124 in the 1990s to 27 in the 2010s. In contrast to adult patients, there was male predominance in sexual distribution of teenage patients.

In summary, the epidemiological characteristics of teenage patients with tinea capitis were different from those of children and adults with tinea capitis in annual incidence, sexual distribution and isolated dermatophytes. The incidence of tinea capitis is decreasing. In addition, *T. tonsurans* has recently emerged as a new common causative fungus in teenage patients with tinea capitis, especially in wrestlers and judoists. These findings may be useful for the treatment and prevention of tinea capitis in teenagers.

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CONFLICT OF INTEREST

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

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