Asymptomatic dermatophyte scalp carriage in school children in Adana, Turkey

Macit Ilkit,¹ Hakan Demirhindi,² Mesut Yetgin,¹ Aylin Ates,¹ Aygül Turaç-Biçer¹ and Erkan Yula¹

Departments of ¹Microbiology and ²Public Health, Faculty of Medicine, University of Çukurova, Adana, Turkey

Summary

The aim of this study was to determine the prevalence of asymptomatic dermatophyte scalp carriage and symptomatic tinea capitis in Adana Province, Çukurova region, Turkey. For this purpose, a screening study was performed in five schools, between January 2004 and May 2005, covering a total of 5143 children with 2740 (53.3%) boys and 2403 (46.7%) girls, aged 7–14 years (9.6 ± 2.0). The diagnosis was made using the cotton swab method with inoculation onto Sabouraud glucose agar amended with cycloheximide, chloramphenicol and gentamicin. Among 10 (0.2%) cases, six asymptomatic carriers (mean age 10.7 ± 2.3) and four symptomatic cases (mean age 8.3 ± 0.5) were detected, all of whom were boys and had immigrated from the southeastern and eastern region of Anatolia, Turkey. The mean age differences were found to be statistically significant (Mann–Whitney U = 3.000, P = 0.046). Boys were found to be more prone to asymptomatic carriage (P = 0.033), but not tinea capitis (P > 0.05). Zoophilic dermatophytes, namely Microsporum canis (40%) and Trichophyton mentagrophytes var. mentagrophytes (40%) were the most commonly isolated species, followed by anthropophilic Trichophyton tonsurans (10%), while no causative agent was detected in a case (10%) with tinea capitis superficialis. Scalp cultures were found to be dermatophyte-negative after 3- to 8-month follow-up in cases with asymptomatic carriage. As a conclusion, the prevalence of asymptomatic carrier state was similar with the prevalence of symptomatic cases, and we found a predominance of zoophilic species.

Key words: tinea capitis, asymptomatic carrier, zoophilic dermatophyte, Microsporum canis, Trichophyton mentagrophytes.

Introduction

Tinea capitis is a dermatophyte infection of the scalp seen predominantly, but not exclusively, in prepubertal children.¹ The clinical hallmark of tinea capitis is hair loss, which may be accompanied by signs of inflammation, such as scaling, itching and pustule formation.² In 1960, Mackenzie et al.³ firstly described dermatophyte-positive scalp cultures, obtained from the hair-brushes and clothing of several children who were 'not ostensibly infected'. An asymptomatic carrier is defined as an individual who has dermatophyte-positive scalp culture without signs or symptoms of tinea capitis. This should also include no evidence of hair shaft invasion confirmed by direct microscopy.¹,²,⁴,⁵

Asymptomatic scalp carriage appears to be organism-specific.¹,²,⁴,⁵ Anthropophilic dermatophytes, i.e. Trichophyton tonsurans,⁶–¹¹ T. violaceum,¹⁴–¹⁶ Microsporum audouinii,¹⁷ M. ferrugineum¹⁸ and M. rivalieri¹⁹ have been generally associated with high rates of asymptomatic carriage. This was attributed to relative lack of host response and, hence these fungi were thought to be good candidates for asymptomatic carriage. In contrast, zoophilic organisms, such as M. canis or T. mentagrophytes, usually demonstrate a symptomatic inflamma-
tory response, and they are less likely lead to asymptomatic carriage. More recently, geophilic M. nanum, T. terrestre, T. ajelloi and M. gypseum are reported to be associated, but in a decreased level with asymptomatic carriage.

To date, however, there have been no data on asymptomatic dermatophyte scalp carriage in Turkey. The present study was therefore conducted to examine the prevalence and causative agents of infection and carrier state of dermatophyte fungi on the scalps of school children in Adana, Turkey.

Materials and methods

Adana province, populated by over 1.5 million inhabitants, is the fifth largest province in Turkey and located in Cukurova region along the Mediterranean coast, at latitude 35°N and longitude 37°E. The climate is warm (9.5 °C) and rainy (132.2 kg m⁻² month⁻¹) in the winter, and hot (27.5 °C) and dry (1.6 kg m⁻² month⁻¹) in the summer time. The relative humidity is high (57.9–76.9%) for most of the year.

After obtaining written permission from Cukurova University, Faculty of Medicine Deanship, Provincial Directorate of National Education and Adana Governorship, five primary schools in Adana city centre were visited. A total of 5143 children, aged 7–14 years with a mean of 9.6 ± 2.0, comprising 2740 (53.3%) boys and 2403 (46.7%) girls, attending 112 classes, were examined and sampled for asymptomatic scalp carriage and tinea capitis from January 2004 to May 2005. Students were examined in their classrooms. For all students, details were taken relating to age, gender, co-sleeping, comb sharing and presence of animal pets or domestic animals in the child’s environment.

Methods of identifying dermatophytes

Sample collection.
Each child’s scalp was examined for broken hairs and/or alopecia, scaling and crusting. After cleaning with 70% alcohol; if such areas were evident, a sample was obtained by vigorously rubbing the affected scalp with a cotton swab. If no clinical signs or symptoms of infection were present, the scalp samples were collected by brushing the right and left sides of the scalp four times vigorously rubbing and rotating the swab.

Culture
The swab was inoculated onto Sabouraud glucose agar (SGA: Acumedia, Baltimore, MD, USA) amended with a mixture of 100 μg ml⁻¹ cycloheximide, 100 μg ml⁻¹ chloramphenicol and 50 μg ml⁻¹ gentamicin, rotating the swab head while streaking the surface of the medium, and then transferred to the Mycology Laboratory, Faculty of Medicine, University of Cukurova. The cultures were incubated at 25 °C in air and were examined after 7, 14 and 21 days for evidence of growth.

Identification of dermatophyte species
Fungal isolates, if any, were subcultured onto SGA and potato dextrose agar (Merck, Darmstadt, Germany) in petri dishes. Identification of dermatophytes was performed by macro- and micro-morphological examination of colonies, by biochemical methods i.e. growth in rice grains and urease tests. The one T. tonsurans strain isolated in this study was confirmed by more luxuriant growth on Trichophyton 4 agar than on Trichophyton 1 agar.

Follow-up
The asymptomatic carriers were followed-up for the development of clinical lesions, or continuation of carrier state or becoming culture negative. The carriers were visited in their classrooms after the isolation of dermatophyte fungi. Two physicians visited each patient once, 3–8 months later.

Statistical analysis
Data were compared for the presence of asymptomatic carriage or symptomatic tinea capitis using Fisher’s exact test, and ages were compared using Mann–Whitney U-test (MWU).

Results
Among a total of 10 (0.2%) cases, being all boys and immigrants from the south-eastern and eastern region of Anatolia, Turkey, six were asymptomatic carriers (mean age 10.7 ± 2.3) and four cases of tinea capitis superficialis (mean age 8.3 ± 0.5). The mean age differences were found to be statistically significant (MWU = 3.000, P = 0.046). All of the 10 children belonged to families of low socio-economic level. Zoophilic dermatophytes, namely M. canis (40%) and T. mentagrophytes var. mentagrophytes (40%) were the most commonly isolated species, followed by anthropophilic T. tonsurans (10%), but the causative agent could not be isolated in one case (10%) with tinea capitis (Table 1). In this case, direct microscopical examination

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with 15% potassium hydroxide revealed ectothrix infection, however, the culture was negative.

While two symptomatic cases with *M. canis* isolated were classmates, all the other eight students were reported to attend different classes. Statistical data revealed that asymptomatic carriage was significantly more prevalent among boys (*P* = 0.033), with no significant relationship observed for tinea capitis (*P* > 0.05). Age, co-sleeping (observed in none of the cases), comb sharing (10/10 cases) and presence of animal pets or domestic animals (3/10 cases) had no relationship with neither asymptomatic carriage nor tinea capitis (*P* > 0.05). Follow-up of asymptomatic carriers for 3–8 months, revealed that the carrier state had disappeared with none of the clinical cases developing clinical lesions.

**Discussion**

Today in Turkey, the clinical forms and the distribution of causative agents of tinea capitis differ from region to region. In Marmara,25 Aegean,26,27 Mediterranean,28,29 Central Anatolia,30 South-eastern Anatolia31 and Eastern Anatolia32 regions tinea capitis superficialis is seen more frequently, while according to a recent report from Eastern Anatolia kerion Celsi has been observed.33 The most frequent causative agents according to the regions are *M. canis* in Aegean,26,27 Central Anatolia34 and Eastern Anatolia32 regions, *T. violaceum* in Mediterranean28,29 and south-east Anatolia,31,35,36 and *T. verrucosum* in Central Anatolia30 and Eastern Anatolia33 regions. Symptomatic tinea capitis studies targeting primary school children performed in Erzurum,32 Istanbul,25 Izmir,26 Diyarbakir,36 Batman31 and Afyon30 reported prevalences of 0.08%, 0.08%, 0.1%, 0.1%, 0.2% and 0.4% respectively. In Adana province, the prevalence observed is 0.05% and slightly lower than that of the other provinces in Turkey.28,29

The prevalence of dermatophyte-positive scalp carriage varies considerably, but it generally correlates well with the incidence of tinea capitis in the community, as in our study.10,11,13,15,21 In Spain, where tinea capitis has been relatively rare, the prevalence of asymptomatic carriage in unselected school children was 0.2%.10,11 Similar results were reported from Germany,22 Italy20 and Palestine,21 revealing an asymptomatic carriage rate of 0.1%, 0.3% and 0.8% respectively. The rate was observed to reach higher values as 4.0%, 4.5%, 4.9%, 7.8% and 14% in Kansas (USA),6 Egypt,16 UK,19 Cleveland (USA)13 and Philadelphia (USA)9 respectively. Asymptomatic carriage rate in Ethiopia as 17% by Figueroa *et al.* [15] and in Nigeria was reported as 24.5% by Ives [17]. In contrast, higher prevalence rates (49%) of asymptomatic carriage have been reported in the Cape Peninsula of South Africa, where *T. violaceum* tinea capitis is endemic.14

As discussed above, the prevalence of asymptomatic carriage showed marked variation, but tends to mirror the prevalence of tinea capitis in the local population. Moreover, Ghannoum *et al.* [13] stated that the differences in these incidences may reflect differences in the study populations and methodologies diagnosing the carrier state. i.e. hairbrush,3,10,11,14,17–19,21 toothbrush,8,12,15,22 scalpel blade,6 gauze11 or carpet disc20 method. In our study, asymptomatic carriage rate was found to be too low, probably due to the use of cotton swab method or as an indicator of a lower prevalence in Europe.

The current state of our knowledge about asymptomatic carriage is that it is mostly caused by anthropophilic dermatophytes, but not being related to a specific dermatophyte species.1,3,5,17–19,21 In contrast to the literature, Ali-Shtayeh *et al.* [21] reported that asymptomatic carriage was caused mainly by the zoophilic dermatophyte *M. canis* (65.6%), followed by anthropophilic dermatophytes (*T. tonsurans, T. violaceum, T. concentricum* and *Epidermophyton floccosum*) (25%), and the geophilic *M. nanum* (9.6%). However, the authors reported that in index cases, *T. violaceum* was the main agent (82.6%) followed by *M. canis* (17.4%). Our study is consistent with this report: indeed, zoophilic *M. canis* and *T. mentagrophytes* were the dominant species, although in one child anthropophilic *T. tonsurans* was isolated. Moreover, recent studies conducted in our region showed that *T. violaceum* was the predominant causative agent of tinea capitis, followed by *T. mentagrophytes, M. canis* and *T. tonsurans*.25 These data suggest that asymptomatic carriage can be expected

**Table 1** Asymptomatic carriage and symptomatic tinea capitis in school children in Adana, Turkey

<table>
<thead>
<tr>
<th>Age</th>
<th>AC</th>
<th>TCS</th>
<th>Contact Antimicrobial</th>
<th>Agent</th>
<th>Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8</td>
<td>+</td>
<td>–</td>
<td><em>T. mentagrophytes</em></td>
<td>3 month</td>
</tr>
<tr>
<td>2</td>
<td>9</td>
<td>+</td>
<td>–</td>
<td><em>T. tonsurans</em></td>
<td>3 month</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>+</td>
<td>–</td>
<td><em>T. mentagrophytes</em></td>
<td>6 month</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
<td>+</td>
<td>–</td>
<td>Cat</td>
<td><em>T. mentagrophytes</em></td>
</tr>
<tr>
<td>5</td>
<td>13</td>
<td>+</td>
<td>–</td>
<td><em>M. canis</em></td>
<td>8 month</td>
</tr>
<tr>
<td>6</td>
<td>14</td>
<td>+</td>
<td>–</td>
<td><em>M. canis</em></td>
<td>8 month</td>
</tr>
<tr>
<td>7</td>
<td>8</td>
<td>–</td>
<td>+</td>
<td><em>M. canis</em></td>
<td>Not done</td>
</tr>
<tr>
<td>8</td>
<td>8</td>
<td>–</td>
<td>+</td>
<td>Cat</td>
<td><em>M. canis</em></td>
</tr>
<tr>
<td>9</td>
<td>8</td>
<td>–</td>
<td>+</td>
<td>–</td>
<td>Not done</td>
</tr>
<tr>
<td>10</td>
<td>9</td>
<td>–</td>
<td>+</td>
<td>Dog</td>
<td><em>T. mentagrophytes</em></td>
</tr>
</tbody>
</table>

AC, asymptomatic carriage; TCS, tinea capitis superficialis.
among people in close contact with animals and/or with people already infected with zoophilic dermatophytes.

The presence of dermatophytes on healthy scalp of children is considered as a potential source of infection. Their presence probably plays an important role in the spread and persistence of tinea capitis among this group of children at an age group most susceptible to infection, and also among classmates, playmates or siblings. On the other hand, both adults and children living with an index case of tinea capitis have been shown to be asymptomatic dermatophyte carriers. However, it is not possible to predict what percentage of the children here identified as carriers, will develop clinical lesions, become culture negative, or continue as carriers. The asymptomatic carrier state has been shown to persist in 10–41% of carriers for as long as 6 weeks to 8 months.

Ive, [17] in 1966, followed up 77 healthy children in Nigeria: 19 children (25%) were M. audouinii carriers; 4 months later, four children (21%) developed clinical lesions, eight (42%) continued to carry M. audouinii and seven (37%) became culture-negative. Neil et al. [14] reported persistent carriage of T. violaceum in 25% of asymptomatic carriers followed for 6 weeks to 6 months. Pomeranz et al. [12] stated that one (7%) of the 15 carriers who developed clinical disease, did so by the second-month visit. In our study, 3- to 8-month follow-up of asymptomatic carriers revealed that the carrier state had disappeared and none of the cases had developed clinical lesions (Table 1). The findings of Pomeranz et al. [12] for age, co-sleeping, comb sharing – not to have association with carrier state – were also observed in our study, in relation to both asymptomatic carriage and tinea capitis with an additional evaluation of animal pet or domestic animal contacts (P > 0.05). While they found gender as an unrelated factor, boys were found to be more prone to asymptomatic carriage (P = 0.033), but not to tinea capitis in our study (P > 0.05). It is also interesting to detect animal contact in only one of five carriers with zoophilic dermatophytes.

Midgley and Clayton [18] reported that classrooms with clinically infected children had more carriers (12–30%) than classes with no index case (1–5%). Once index cases had been removed from the classroom, the percentage of children in the carrier state decreased and disappeared. The authors hypothesised that spores shed from index patients were spread to scalps of uninfected children. There may be an increased frequency of transmission of conidia in children in the lower age groups, where there is a greater degree of physical contact. A survey of school children in south-east London showed that 2.5% had tinea capitis, and that about 4.9% were carriers. The authors also reported that in those school classes, where at least two school children were infected, there was a higher chance of carriage. Williams et al. [9] did not substantiate these findings, as mean carrier rate for classes without index cases was higher than the mean rate for classes containing index cases. In our study, except two tinea capitis cases due to M. canis who were classmates, all the other eight students were reported to be from different classes. This may be due to the high prevalence of zoophilic dermatophytes.

There are no differences in the prevalences of symptomatic cases of tinea capitis in different regions of Turkey, however, causative agents differ from region to region, and even in a single region. Thus, dermatophytes associated with asymptomatic carriage need to be determined in every region. In conclusion, this study emphasises the presence of asymptomatic carriage, as an important but mostly neglected factor of tinea capitis in the community, as school-age children may be an infection source, reminding the role of school health among public health activities. Another contribution to the literature is the demonstration of zoophilic species mostly associated with asymptomatic carriage, in the contrary of accustomed opinion of being anthropophilic of nature. Hence, it introduces new insights to control tinea capitis in Adana province.

References
9 Williams JV, Honig PJ, McGinley KJ, Leyden JJ. Semi-quantitative study of tinea capitis and the asymptomatic