Factors Influencing Coexistence of Toenail Onychomycosis With Tinea Pedis and Other Dermatomycoses

A Survey of 2761 Patients

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Objective: To evaluate the prevalence and factors influencing the presence of concomitant dermatomycoses in patients with toenail onychomycosis.

Design: Prospective study based on a specially designed questionnaire completed by dermatologists.

Patients: A total of 2761 patients with toenail onychomycosis.

Main Outcome Measures: The diagnosis of fungal skin infections was confirmed by direct microscopic examination or by culture.

Results: In 1181 patients (42.8%) with toenail onychomycosis, concomitant fungal skin infections were noted. Tinea pedis was the most common and was found in 933 patients (33.8%). Other concomitant fungal skin infections were fingernail onychomycosis (7.4%), tinea cruris (4.2%), tinea corporis (2.1%), tinea manuum (1.6%), and tinea capitis (0.5%). The presence of concomitant fungal skin infections depended on number of involved toenails; duration of onychomycosis; sex, age, and education level; area of residence; and type of isolated fungus.

Conclusions: The coexistence of toenail onychomycosis with other types of fungal skin infections is a frequent phenomenon. It could be hypothesized that infected toenails may be a site from which the fungal infections could spread to other body areas. Effective therapy for onychomycosis might therefore be essential not only to treat the lesional toenails but also to prevent spreading the infection to other sites of the skin.

Arch Dermatol. 2006;142:1279-1284

Arch Dermatol. 2006;142:1279-1284

Methods

This prospective study was carried out in Poland between September 2004 and April 2005. It was based on a specially designed questionnaire with demographic and clinical details of patients entered by dermatologists during the patient visit. Every patient underwent careful dermatologic examination. The clinical diagnosis of toenail onychomycosis and other concomitant fungal skin infections was confirmed by direct microscopic examination or by culture on Sabouraud agar.

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Data regarding 2761 patients with toenail onychomycosis obtained from 241 dermatologists were analyzed. The clinical diagnosis of toenail onychomycosis was confirmed by the positive findings on direct microscopic examination in 1394 patients (50.5%) or by the growth on mycologic culture in another 1367 patients (49.5%). There were 1248 men (45.1%) and 1519 women (54.9%) ranging in age from 18 to 86 years (mean ± SD age,
49.1 ± 13.7 years), including 282 patients (10.2%) 30 years or younger, 1818 patients (65.9%) aged between 31 and 60 years, and 655 patients (23.7%) older than 60 years. In 6 cases, data regarding the patient’s age were missing.

A total of 337 individuals (12.9%) had no education beyond elementary school; 1423 (51.5%) had a high school education; and 946 (34.3%) had a university education. Thirty-five patients (1.3%) did not provide information about their education. Three hundred twenty-five patients (11.8%) were living in rural areas, 968 (35.1%) in small towns (≤100,000 residents), and 1362 (49.3%) in a city (>100,000 residents). For 106 patients (3.8%), data regarding the area of residence were not available.

All results were analyzed statistically using Statistica 6.0 (StatSoft, Krakow, Poland) for Windows (Microsoft Corp, Redmond, Wash). The following statistical tests were used: the unpaired t test, χ² test, Spearman rank correlation test, and the Schelé post hoc test in a univariate analysis of variance setting, as appropriate. Significance was set at P < .05.

### RESULTS

The most common fungi cultured from infected toenails were dermatophytes (n = 1119; 81.9%) followed by yeasts (n = 83; 6.1%) and molds (n = 52; 3.8%). In 37 patients (2.7%), both dermatophytes and yeasts were cultured; in 20 (1.5%), both dermatophytes and molds; in 3 (0.2%), dermatophytes, yeast, and molds; and in 9 (0.6%), both yeast and molds. In 44 subjects (3.2%), no information about the cultured pathogen was provided despite positive mycologic culture results. The most often observed dermatophytes were *Trichophyton rubrum* (52.4%) and *Trichophyton mentagrophytes* (24.5%).

The duration of onychomycosis ranged between 1 month and 22 years (mean ± SD duration, 17.9 ± 19.9 months). The mean ± SD number of involved toenails was 4.4 ± 2.7 (range, 1-10 toenails), and the number of involved toenails correlated with the duration of onychomycosis (R = 0.37; P < .001). In 676 individuals (24.5%), the disease was unilateral, and in 2081 patients (75.4%), the toenails of both feet were involved. In 915 subjects (33.1%), a recurrent onychomycosis was diagnosed.

In 1181 patients with toenail onychomycosis (42.8%), concomitant fungal skin infection was noted: 1 type of fungal skin infection in 1005 patients (36.4%), 2 types in 162 patients (4.7%), 3 types in 13 patients (0.4%), and 4 types in 1 patient.

Coexistence of tinea pedis and toenail onychomycosis was found in 933 patients (33.8%). The most commonly observed subtype of tinea pedis was interdigital (610 patients) followed by hyperkeratotic (105 patients) and dyshidrotic subtypes (102 patients). In 59 subjects, we found both interdigital and hyperkeratotic tinea pedis; in another 45, we found both interdigital and dyshidrotic tinea pedis. In 11 patients with tinea pedis, no data regarding the subtype were available (Table 1). Concomitant tinea pedis in all of its subtypes was more often observed in male patients (P < .001) and in subjects with recurrent toenail onychomycosis (P < .001), more advanced toenail onychomycosis, ie, in patients with bilateral toenail onychomycosis (P < .001), and a higher number of involved toenails (P < .001) (Table 2). In addition, the hyperkeratotic tinea pedis was significantly more prevalent in older patients (P < .001) (Table 2).

Regarding education level, patients with less education more often had dyshidrotic (P = .02) and hyperkeratotic subtypes (P = .001) of concomitant tinea pedis compared with patients with higher education levels (Table 2). Moreover, interdigital tinea pedis was found more frequently in cases of mixed culture (P < .01). Additionally, in cases of *T mentagrophytes* infections, dyshidrotic tinea pedis was more prevalent than in cases of *T rubrum* infections (P = .03). The area of residence did not influence the frequency of tinea pedis in patients with toenail onychomycosis (Table 2).

Analyzing other fungal skin infections (Table 3) in patients with toenail onychomycosis, we found that fingernail onychomycosis was most common (n = 205; 7.4%) followed by tinea cruris (n = 117; 4.2%). Tinea corporis was found in 59 subjects (2.1%), tinea manuum in 45 (1.6%), and tinea capitis in 13 (0.5%).

Concomitant fingernail involvement was significantly more prevalent among patients in the following categories: older than 30 years (P < .01), rural area of residence (P < .001), lower education level (P < .001), bilateral involvement of toenails (P < .01), higher number of involved toenails (P < .001), and recurrent toenail onychomycosis (P = .03). In addition, fingernail onychomycosis was more frequently present in cases with mixed culture findings (P < .001) (Table 3). Tinea cruris was more often found in male patients (P < .001), older patients (P < .05), in subjects living in rural areas (P = .01), with lower education level (P < .05), with recurrent onychomycosis (P = .04), and with a higher number of involved toenails (P < .001) (Table 3). Tinea corporis was significantly more often noted in patients living in rural areas (P = .02) and in subjects with a lower education level (P = .01) (Table 3). Concomitant tinea manuum was more frequently found in individuals with a higher number of involved toenails (P = .001) (Table 3). Finally, tinea capitis was more frequently observed in male patients with toenail onychomycosis (P < .05) (Table 3).

### COMMENT

The Achilles screening project revealed that 56% to 62% of dermatologic patients had foot disease independent of their presenting medical complaints. In the European part
of the study, fungal infections (35%), including tinea pedis (22%) and onychomycosis (23%), were the most commonly clinically diagnosed foot diseases. These observations indicated that both disorders are important and constitute a frequent health problem.

In some subjects tinea pedis and toenail onychomycosis may coexist. In the present study, we observed that about a third of patients with toenail onychomycosis also had tinea pedis. These data are similar to previously published studies.\(^9\)\(^,\)\(^12\) Additionally, we noted that other types of fungal skin infections may be relatively common in patients with toenail onychomycosis, especially in cases of fungal infections may be relatively common in long-duration nail disease.

It should be emphasized that the extent of toenail onychomycosis and recurrent disease were the most important parameters influencing the coexistence of tinea pedis. Moreover, in previously published data, fingernail onychomycosis coexisted with tinea manuum in nearly 10% of patients and with other dermatomycoses in about 5%.\(^10\) Based on the achieved results and our own experience, we believe that infected fingernails and toenails may be a site of primary infection, and fungal disease could spread to other body areas from infected fingernails and toenails later on. This probability indicates the necessity for every patient with tinea manuum to receive effective treatment to prevent development of other tinea types.

It is also worth mentioning that many patients with toenail onychomycosis or tinea pedis are not aware that they have a fungal infection, and such patients pose a special challenge for physicians to detect and treat the disease.\(^11\)\(^,\)\(^13\) We should also remember that it was clearly shown that tinea pedis may precede toenail onychomycosis.\(^14\)

The most commonly isolated fungi from toenails in our population were dermatophytes, which is in accordance to other published data.\(^10\)\(^,\)\(^15\)\(^,\)\(^16\) According to our observations and results presented by other authors,\(^15\)\(^,\)\(^17\) T. rubrum seems to be the most commonly found species in infected toenails. However, this may depend on the type of onychomycosis. It has been observed that in superficial onychomycosis, T. mentagrophytes appeared to be slightly more common than T. rubrum.\(^6\) Interestingly, in the present study we found that T. rubrum toenail infection was connected with higher risk of the development of dystrophic toenail pedis. To our knowledge, this relation has not been previously reported.

We also found that coexistence of toenail onychomycosis and tinea pedis was more prevalent in men. This phenomenon could be explained by the fact that, generally, both disorders are more common among men.\(^10\)\(^,\)\(^11\)\(^,\)\(^16\)\(^,\)\(^18\) The coincidence of tinea pedis and toenail onychomycosis also increased with age, and it is estimated that 23.7% of elderly individuals have both types of infections.\(^17\) Older patients have demonstrated sig-
Table 3. Prevalence of Fungal Skin Infections Other Than Tinea Pedis in Patients With Toenail Onychomycosis

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Tinea Capitis</th>
<th>Tinea Corporis</th>
<th>Tinea Crusis</th>
<th>Tinea Manum</th>
<th>Finger nail Onychomycosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>10</td>
<td>1238</td>
<td>.05</td>
<td>.96</td>
<td>.001</td>
</tr>
<tr>
<td>Female</td>
<td>3 (0.2)</td>
<td>32</td>
<td>(2.2)</td>
<td>(97.8)</td>
<td>(6.8)</td>
</tr>
<tr>
<td>Age, mean ± SD</td>
<td>45.5 ± 16.8</td>
<td>49.1 ± 13.6</td>
<td>34</td>
<td>48.6 ± 15.2</td>
<td>49.1 ± 13.6</td>
</tr>
<tr>
<td>Area of residence‡</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>.88</td>
<td>.28</td>
<td>.01</td>
<td>.88</td>
<td>.01</td>
</tr>
<tr>
<td>Town</td>
<td>5 (0.9)</td>
<td>963</td>
<td>(1.9)</td>
<td>(98.1)</td>
<td>(3.6)</td>
</tr>
<tr>
<td>City</td>
<td>7 (0.5)</td>
<td>1352</td>
<td>(2.0)</td>
<td>(98.0)</td>
<td>(4.1)</td>
</tr>
<tr>
<td>Education</td>
<td>.01</td>
<td>.28</td>
<td></td>
<td>&lt;.05</td>
<td>.38</td>
</tr>
<tr>
<td>Elementary</td>
<td>1 (0.3)</td>
<td>356</td>
<td>(4.3)</td>
<td>(95.7)</td>
<td>(7.4)</td>
</tr>
<tr>
<td>High school</td>
<td>9 (0.6)</td>
<td>1414</td>
<td>(1.8)</td>
<td>(98.1)</td>
<td>(3.9)</td>
</tr>
<tr>
<td>University</td>
<td>2 (0.2)</td>
<td>944</td>
<td>(1.9)</td>
<td>(98.1)</td>
<td>(3.8)</td>
</tr>
<tr>
<td>Localization</td>
<td>.84</td>
<td>.99</td>
<td>.25</td>
<td>&lt;.01</td>
<td>.85</td>
</tr>
<tr>
<td>Unilateral</td>
<td>4 (0.6)</td>
<td>672</td>
<td>(2.2)</td>
<td>(97.8)</td>
<td>(3.4)</td>
</tr>
<tr>
<td>Bilateral</td>
<td>9 (0.4)</td>
<td>2072</td>
<td>(2.1)</td>
<td>(97.9)</td>
<td>(4.5)</td>
</tr>
<tr>
<td>First presentation</td>
<td>1397</td>
<td>35</td>
<td>(1.9)</td>
<td>(98.1)</td>
<td>(3.8)</td>
</tr>
<tr>
<td>of toenail</td>
<td>.001</td>
<td>.01</td>
<td>.28</td>
<td>.23</td>
<td>.001</td>
</tr>
<tr>
<td>mean ± SD</td>
<td>2.2 ± 2.7</td>
<td>2.4 ± 2.7</td>
<td>2.7 ± 2.7</td>
<td>2.7 ± 2.7</td>
<td>2.7 ± 2.7</td>
</tr>
<tr>
<td>Recurrent toenail</td>
<td>2 (0.2)</td>
<td>913</td>
<td>(2.4)</td>
<td>(97.6)</td>
<td>(5.8)</td>
</tr>
<tr>
<td>onychomycosis</td>
<td>.04</td>
<td>22</td>
<td>1383</td>
<td>.26</td>
<td>101</td>
</tr>
<tr>
<td>of toenail</td>
<td>.01</td>
<td>.14</td>
<td>.28</td>
<td>.23</td>
<td>.01</td>
</tr>
<tr>
<td>Culture</td>
<td>.10</td>
<td>.14</td>
<td>.28</td>
<td>.23</td>
<td>.10</td>
</tr>
<tr>
<td>Dermatophyton</td>
<td>5 (0.4)</td>
<td>1114</td>
<td>(1.9)</td>
<td>(98.1)</td>
<td>(4.2)</td>
</tr>
<tr>
<td>Yeasts</td>
<td>2 (0.2)</td>
<td>81</td>
<td>(4.8)</td>
<td>(95.2)</td>
<td>(8.4)</td>
</tr>
<tr>
<td>Molds</td>
<td>0 (0.0)</td>
<td>52</td>
<td>0</td>
<td>52</td>
<td>0</td>
</tr>
<tr>
<td>Mixed culture</td>
<td>0</td>
<td>69</td>
<td>2</td>
<td>67</td>
<td>3</td>
</tr>
<tr>
<td>Trichophyton</td>
<td>1 (0.0)</td>
<td>611</td>
<td>8 (1.7)</td>
<td>604</td>
<td>8</td>
</tr>
<tr>
<td>mentagrophyton</td>
<td>0 (0.0)</td>
<td>286</td>
<td>5</td>
<td>281</td>
<td>13</td>
</tr>
<tr>
<td>rubrum</td>
<td>(0.2)</td>
<td>(98.8)</td>
<td>(1.3)</td>
<td>(98.7)</td>
<td>(4.2)</td>
</tr>
</tbody>
</table>

*Unless otherwise indicated, data are reported as number (percentage) of subjects.
†All P values based on y² test or unpaired t test.
‡Towns had a population of 100 000 residents or fewer; cities had more than 100 000 residents.

More significantly, more advanced toenail onychomycosis with a higher number of involved toenails and longer duration of the disease. However, we noted that only the hyperkeratotic subtype of tinea pedis is significantly more frequent in elderly subjects with toenail onychomycosis.

Interestingly, simultaneous tinea pedis and toenail onychomycosis were also more frequently found in individuals living in the countryside. This observation could be related to the different types of jobs that rural residents perform compared with city residents. Moreover, patients living in the countryside in Poland have limited access to medical care compared with people living in the cities. This may lead to delayed diagnosis of fungal toenail infection, which could be responsible for the spread of disease to other body areas.

A higher percentage of tinea pedis in patients with onychomycosis was also connected with lower education level. The observed differences could be explained by the different work conditions and the different income level, which are generally poorer in patients with lower education. The
treatment of toenail onychomycosis is quite expensive, so it is probable that many patients decided not to treat the disease in the early stages. In our previous study, we noted that patients with lower education levels demonstrated more advanced toenail onychomycosis.

As with tinea pedis, factors responsible for higher prevalence of other dermatomycoses in patients with toenail onychomycosis were male sex, older patient age, lower education level, rural area of residence, and greater severity of toenail onychomycosis. The differences between the particular dermatomycoses are difficult to explain but could be related to different hygiene status, job conditions, and leisure habits.

Our large study including more than 2500 patients with toenail onychomycosis has some limitations. First, many different dermatologists performed the evaluations, which could increase the variability of the collected data. Moreover, not all fungal infections were confirmed by positive cultures; however, in each subject at least direct mycologic test results were positive. We believe that these limitations did not markedly influence the achieved results.

In summary, to our knowledge this is the first large and detailed study evaluating the prevalence of dermatomycoses in patients with toenail onychomycosis. The coexistence of toenail onychomycosis with other types of fungal skin infections is a frequent phenomenon. We hypothesize that infected toenails may be a site from which the fungal infections can spread to other body areas. The effective therapy for onychomycosis is therefore essential not only to treat the lesional toenails but also to prevent spreading the infection to other sites of the skin.

Accepted for Publication: March 2, 2006.

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Author Contributions: Dr Szepietowski had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Szepietowski and Baran. Acquisition of data: Szepietowski, Reich, Garlowska, and Kulig. Analysis and interpretation of data: Szepietowski and Reich. Drafting of the manuscript: Szepietowski, Reich, Garlowska, and Kulig. Critical revision of the manuscript for important intellectual content: Szepietowski, Reich, Garlowska, and Kulig. Statistical analysis: Reich. Obtained funding: Szepietowski, Garlowska, Kulig, and Baran. Administrative, technical, and material support: Reich, Garlowska, Kulig, and Baran. Study supervision: Szepietowski, Reich, and Baran.


Financial Disclosure: None reported.

Funding Support: The study was supported by a research grant provided by Novartis Pharma, Poland (Drs Szepietowski and Reich).

Role of the Sponsor: The sponsor of the study helped to distribute questionnaires among physicians participating in the study but otherwise had no role in the study design, data collection, data analysis, or writing of the article.
Acknowledgment: We thank all the dermatologists who submitted their data for final analysis.

REFERENCES