A comparative study of dermatophytosis in coal miners and dermatological outpatients

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ABSTRACT The causative organisms and susceptibility factors were compared in two groups of individuals with tinea pedis, coal miners (234) and dermatological outpatients (244). *Trichophyton rubrum* was the commonest dermatophyte in both groups, being isolated from 71% of infected miners and 77% of infected outpatients. The incidence of atopy in the outpatients, but not the miners, was significantly higher in individuals with *T. rubrum* infections than in control groups. An analysis of the data from both groups suggests that in the coal miners, in whom there is a high risk of endemic dermatophytosis, susceptibility factors such as atopy are of less importance than in patients seen in a dermatological outpatient clinic in whom the risk of exposure to other sources of dermatophytosis is low.

Tinea pedis is well recognised as a form of endemic dermatophytosis in communities such as schools¹ and occupational groups.² In the United Kingdom it is a common infection among coal miners.³ Reasons for the development of this infection in miners include the ease of transmission of dermatophytes in pit head shower rooms, the heavy footwear worn, and the humid working conditions which may facilitate invasion of stratum corneum by the fungi. Gentles and Holmes suggested that other factors such as age, season, and conditions of employment were of lesser importance.³ Dermatophyte infections in miners are often chronic, although it is not clear whether this represents persistence of the original infection or repeated reinfection.

In hospital practice chronic infections with dermatophytes are not uncommon. In this group of patients host susceptibility factors such as an underlying history of atopy as well as the specific features of the invading fungus both contribute to the persistence of the infection.⁴ To determine the importance of similar factors in patients with occupational dermatophytosis we have studied two groups of individuals in whom dermatophyte infections are regularly diagnosed, coal miners and dermatological outpatients. In this initial study we have compared the infecting organisms, working practices, and susceptibility factors in both groups irrespective of the course of the infection.

Patients

The coal miners studied were all employed at Arkwright Colliery near Chesterfield (North Derbyshire regional area of the National Coal Board). Those participating in the study were volunteers with "symptomatic" or clinical abnormalities of the feet and who appeared to be clinically infected. Most showed itching, cracking, maceration, blistering, or scaling of toe web spaces. Those with abnormal but microscopy and culture negative toe web spaces were used as control subjects.

The dermatological outpatients were all attending St John's Hospital for Diseases of the Skin, London, and had had tinea pedis confirmed by positive direct microscopy of foot scrapings. A control group of 62 patients with skin disease other than dermatophytosis affecting the feet was also studied. The conditions included psoriasis (12), chronic foot eczema (30), keratoderma (five), and other non-fungal conditions (15).

In both groups skin scrapings from the toe web spaces were examined by direct microscopy and culture. Individuals were also given a questionnaire form requesting details of their present condition. Nursing, laboratory, or medical staff helped both groups to answer the questionnaire. The questions posed included: a past or present history of atopic disease such as hay fever, atopic eczema, or asthma in subjects or their close relatives (siblings, parents, children), the duration and frequency of the infection, whether it was continuous or intermittent, and

the treatments given. In addition to these questions, the miners were asked for further information including: their working site (above or underground), duration of service, and presence of proved infection before starting work in the mine. In this group the presence of lesions compatible with infection of the sole or toe nail was noted by nursing staff.

Scrapings were taken from affected sites from both groups and examined by direct microscopy. Cultural isolations were carried out on Sabouraud's agar.

Results

In the group of coal miners 234 individuals were investigated. Their mean age was 43 (range 17–60) and all were male. The mean period of service with the National Coal Board was 21 years (range 6 months–45 years). Most of those investigated were working underground, only 31 (13%) were currently working on the surface.

On clinical examination all investigated miners had abnormal toe web spaces and 91 (39%) had positive dermatophyte cultures (table 1). It can be seen from table 2 that in miners infected with *Trichophyton rubrum* or *T interdigitale* there was no significant difference in the prevalence of atopic disease in individuals or their relatives. Likewise symptoms and signs were equally persistent in both groups. Of those infected with *T rubrum*, however, 65% had scaling or blistering on the soles compared with only 9% of those with *T interdigitale* ($p < 0.001$); and abnormal toe nails suggestive of

onychomycosis were noted in 32% of the *T rubrum* and 9% of the *T interdigitale* groups ($p < 0.001$). There was no difference in the duration of service in individuals infected with either organism. For instance, 53% of patients with *T rubrum* and 48% of those with *T interdigitale* had served with the National Coal Board for over 20 years ($p > 0.05$). No patients admitted the presence of abnormal toe web spaces before starting employment with the National Coal Board.

Of the 244 hospital outpatients, including control subjects, who were studied, 148 were men and 96 were women: their mean age was 34 (range 17–68).

Table 1 shows the results of the cultures.

By contrast with the group of coal miners the presence of atopy was significantly associated (table 2) with infections caused by *T rubrum* as compared with those caused by *T interdigitale* or the control subjects. Likewise, the patients with *T rubrum* were significantly more likely to have continuous symptoms whereas *T interdigitale* infections tended to be intermittent.

At follow up six months later, 45% (52) of the patients with *T rubrum* remained infected despite treatment with topical antifungal agents or griseofulvin, and 24 (46%) had a personal or family history of atopy compared with 17 (26%) of those who had responded to treatment ($0.05 < p < 0.01$). The presence of atopy appears to influence the response to treatment even though it is also present in a much higher proportion of responder patients with *T rubrum* infections (26%) than non-infected controls (15%). It was not possible to obtain similar follow up information in the coal miners.

Table 1 *Dermatophyte cultures in coal miners and dermatological outpatients*

	<i>Trichophyton rubrum</i>	<i>Trichophyton interdigitale</i>	<i>Epidermophyton floccosum</i>	No growth
Coal miners (n = 234)	65 (57)*	21 (16)*	5 (4)*	143 (22)*
Dermatology outpatients (n = 244)	116 (110)*	27 (26)*	7 (7)*	94† (32)*

*No of subjects in each group with positive microscopy.

†Includes 62 control subjects without dermatophytosis.

Table 2 *Prevalence of atopic disease in individuals or their relatives*

	Miners (% of those infected with)			Outpatients (% of those infected with)		
	<i>T rubrum</i>	<i>T interdigitale</i>	Control group	<i>T rubrum</i>	<i>T interdigitale</i>	Control group
Personal or family history of atopy	12	15	14	35	15	14
p	> 0.05*	> 0.05*		< 0.001*	> 0.05*	
Continuous toe web abnormalities	30	26	—	36	7	—
p	> 0.05†			< 0.001†		

*Significance between percentages of those infected by specific organisms compared with control subjects.

†Significance of difference between subjects infected by *T rubrum* and *T interdigitale*.

Discussion

Among coal miners working in one area of the United Kingdom dermatophyte fungi were isolated from 39% of those with abnormal toe web spaces and *T rubrum* was the commonest organism, occurring in 71% of those with positive cultures. In a hospital outpatient group *T rubrum* was also the predominant organism in 77% of cases. In the hospital group patients infected with *T rubrum* were significantly more likely to have underlying atopy as compared with the coal miners when a personal or family history of atopy was present in an equal proportion of both infected and control groups. Persistence of symptoms in tinea pedis caused by *T rubrum* and intermittent symptoms in *T interdigitale* infections were a significant feature of dermatophytosis in hospital patients but not miners. There was also no evidence to suggest that the identity of the infecting organism in coal miners was affected by their duration of service with the coal board.

The association between chronic dermatophytosis, particularly *T rubrum* infections, and atopy has been noted elsewhere.^{4,5} Atopic subjects appear to be more susceptible to persistent infection, possibly because of T lymphocyte hyporeactivity⁶ or histamine modulation of T lymphocyte mediated responses.⁷ Cell mediated immunity is of great importance in recovery from dermatophytosis,⁸ and defective T cell responses may well lead to persistence of the infection. Nevertheless, in the hospital outpatients there was a significant association between underlying atopy and *T rubrum* infections irrespective of their course. This is not surprising as the results of treatment of some dermatophyte infections, particularly dry type *T rubrum* infections cannot be predicted reliably; and while undoubtedly influencing the likelihood of relapse, susceptibility in the host may not necessarily prejudice the chances of recovery after a given course of treatment.

The individuals attending the hospital outpatient department were not exposed to the same extent to sources of dermatophyte infection as the miners. In the miners' group there was a frequent opportunity for transmission of organisms in shower rooms and the humid working conditions could facilitate invasion of toe web spaces. It seems likely, therefore, that under these circumstances host susceptibility factors play a minor part in affecting the prevalence,

duration, and relapse of infection. Therefore, a closer understanding of the factors affecting transmission of dermatophyte fungi, such as the extent of contamination of shower room floors by desquamated organisms, may well lead to effective methods of control of these infections in occupationally exposed groups. Local changes in the microenvironment of the toe web spaces such as the carbon dioxide tension of stratum corneum⁹ and the presence of certain large colony coryneforms¹⁰ are also important in determining the likelihood of invasion by adherent fungi. Nevertheless, in the dermatophyte infections which are seen in a hospital outpatient group where the extent and frequency of exposure to other infected individuals is less, factors affecting host susceptibility are of greater importance in influencing the course and prevalence of infections, particularly those caused by *T rubrum*.

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