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Dermatophytes and bacterial superinfections in tinea pedis patients at Haji Adam Malik Central Hospital, Medan-Indonesia

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ABSTRACT

Background: Tinea pedis is a dermatophyte infection of the feet, especially the toes and soles of the feet. The clinical features of tinea pedis consist of four forms. They are interdigital, chronic hyperkeratotic, vesiculobullous, acute ulcerative or a combination. Tinea pedis mainly interdigital type often involved bacterial superinfection, initially Gram-positive bacteria, but Gram-negative bacteria may also be involved. In a state of severe infection, the fungus is getting hard to find. Otherwise, the bacteria were easier to find, so it is necessary to do fungal and bacterial culture with antibiotic sensitivity tests.

Objective: To determine dermatophyte species and bacterial superinfection in tinea pedis at H. Adam Malik General Hospital Medan.

Methods: This study is a descriptive observational with cross sectional design. The results of the study are presented in the form of frequency distribution table. These research involved 45 subjects with tinea pedis who met the inclusion and exclusion criteria. We conducted anamnesis, dermatologic examination, and collection of samples that were skin

scrapings and smears on the lesion. The samples then examined on microscopic directly by using KOH. When KOH result was positive, it followed by fungal and bacterial culture.

Results: The number of subjects who suffer from tinea pedis is not much difference between men (48.9%) and women (51.1%). The highest prevalence was in the age group 37-46 years (28.9%), mostly graduated from elementary school (40%) and mostly housekeepers (22.5%), with the most prevalent type was interdigital of 40 cases (88.9%). Dermatophytes *T. mentagrophytes* was most found by 44.4%, followed by *T. rubrum*, *E. floccosum*, and *T. violaceum*. Bacterial superinfection was mostly involved *S. aureus* by 30.8%, but *B. subtilis*, *S. epidermidis*, *K. oxytoca*, *K. pneumoniae*, *E. coli*, *P. vulgaris* were also found.

Conclusion: Dermatophytes *T. mentagrophytes* were most found followed by *T. rubrum*. Bacterial superinfection *S. aureus* were mostly involved.

Keywords: tinea pedis, dermatophytes, bacterial superinfection

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INTRODUCTION

Tinea pedis is a dermatophyte infection of the feet especially between the toes and the soles of the feet.¹ This disease is estimated to affect 10% of the world's population.¹ The cause of tinea pedis is dermatophyte. The most common dermatophyte in tinea pedis lesions are *Trichophyton rubrum* (*T. rubrum*), *Trichophyton mentagrophytes var interdigitale* (*T. mentagrophytes var interdigitale*) and *Epidermophyton floccosum* (*E. floccosum*).^{1,2,3,4}

Normal microflora on the sidelines of the toes include *Micrococcae* (*staph*), *aerobic coryneform* and some Gram-negative bacteria can proliferate when dermatophytes damage the stratum corneum barrier. It manifests of the development from uncomplicated superficial fungal infections becoming more aggressive with erosion and maceration on the sidelines of the toes.^{5,6}

Tinea pedis especially the interdigital type is often involving of bacterial superinfection which causes the treatment to be difficult.^{7,8,9} also, untreated tinea pedis or improper treatment may lead to secondary infection by bacteria.³ In severe

infections, the fungus was harder to found. Otherwise, bacteria are more easily to be found, so it required the examination of fungal culture and also bacterial culture accompanied by antibiotic sensitivity test.^{1,6}

This study aims to determine dermatophyte species and bacterial superinfection in tinea pedis at H. Adam Malik General Hospital Medan.

METHODS

Research Design

This study is a descriptive observational with cross sectional design. This study conducted at Mycology Division department of dermatology and venereology department of H. Adam Malik Hospital Medan from January to November 2016. This study aims to determine dermatophyte species and bacterial superinfection in tinea pedis at H. Adam Malik General Hospital Medan.

Research Sample

The sample of the study were patients with tinea pedis who fulfilled the inclusion and exclusion criteria.

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Inclusion criteria were patients aged above 17 years with tinea pedis based on clinical examination with positive KOH examination and willing to participate in research by signing *informed consent*. Exclusion criteria are being treated with topical antifungals in the past week, oral antifungals in the past month and oral and topical antibiotics in the past week. 45 samples were taken using consecutive sampling method.

Sampling Technique

Sampling for KOH examination and fungal cultures were selected in lesions with active edges. First, the area is cleaned with 70% cotton alcohol, then awaited dry. Scrambled with the blunt side of sterile scalpels in the areas of active edges. For lesions in the form of vesicles, bullae or pustules, done by opening the roof of the lesion using a sterile scalpel and then scrape the base of the lesion. The specimens were inserted into 2 specimen containers (envelopes) and labeled with patient's identity. Taking a sample of specimens for bacterial culture, swabbed using sterile lid cotton, then inserted into the transport medium swabs and labeled with patient's identity.

Microscopic Examination with KOH

The specimens were taken sufficiently, placed on object glass, dropped with 10% KOH solution then covered with a tumbler glass. The specimens are Flown over a small fire and left for 5 minutes. The specimen was examined under a microscope with a magnification of 10 x 40 to see the presence or absence of hyphae and arthroconidia. When examination results are found hyphae and/or arthroconidia, the investigation is continued to fungal culture and bacterial culture.

Fungal Culture

The specimens were applied to the surface of Sabaroud's dextrose agar medium with added cycloheximide (0.5 g / l) and chloramphenicol (0.05 g / l), then incubated at room temperature (26°C). Observations were made until there was fungal growth (maximum until the fourth week), then identified in macroscopic and microscopic. The macroscopic identification was made by observing the morphology (surface color, base color, surface texture, shape, and edges) of growing fungal colonies. Microscopic identification was performed using lactophenol cotton blue solution, observed hyphae, and conidia (macroconidia and microconidia).

Bacterial Culture

If in the Gram staining examination looks like a chain, signifying a Gram-positive cocci bacteria (*streptococcus*), so the bacterial culture was grown on blood agar medium only. The specimens were

removed from the transport medium swab, applied to the blood agar medium and Mac Conkey agar medium, incubated at 37°C for 24 hours. If in the Gram staining examination looks like grapes, it is suspected the other Gram-positive cocci bacteria (*staphylococcus*), so the bacterial culture was grown on mannitol salt agar medium, incubated at 37°C for 24 hours (the color of *S. aureus* colonies are yellow gold, *S.epidermidis* colonies are white). Whereas, in the Gram staining examination suspected Gram-negative bacilli bacteria (*Enterobacteriaceae*), identified by biochemical reactions.

RESULT

The Research subject of the female gender were 23 people (51.1%), and the male gender were 22 people (48.9%). The average age of the subject was 44.5 years with the youngest age was 18 years old, and the oldest was 68 years old. Two people (4.4%) of the age group of 17-26 years old was found, then 27-36 years old with 9 people (20%), 37-46 years old with 13 people (28.9%), 12 people (26.7 %) of 47-56 years old, 8 people (17.8%) of 57-66 years old and 1 person (2.2%) of 67-76 years old. The education level of the subjects consists of 17 people (37.8%) graduated elementary school graduation, 13 people (28.9%) graduated from junior high school, 13 people (28.9) graduated from high school, and 2 people (4.4%) graduated from college. The subject occupation consisted of 1 person (2.2%) of civil servants, 2 private employees (4.4%), 7 self-employed (15.6%), 6 laborers (13.3%), 6 peasants (13.3%), 10 (22.2%) housemaids, 7 (15.6%) housewives, 3 car washers (6.7%), 1 machine shop workers (2,2%) And 1 person (2.2%) of security guard.

KOH examination results from 45 specimens were found 64.4% of hyphae structure, 24.4% of hypha + arthroconidia and 11.1% of arthroconidia. The most common clinical features of tinea pedis were interdigital types (88.9%), followed by 1 case (2.2%) of vesiculobullous type, 2 cases (4.4%) of interdigital + vesiculobullous and 2 cases (4.4%) interdigital + Hyperkeratotic.

The result of fungal cultures examination showed 39 specimens of dermatophyte found from 45 specimens. The most common dermatophyte species were *T. mentagrophytes* with 20 specimens (44.4%) and 15 specimens (33.3%) of *T. rubrum* (Table 1).

The result of the study showed the most bacteria species found from bacterial cultures of 35 specimens of dermatophyte was *S. aureus* a gram-positive coccus (30.8%), followed by 6 specimens (15.4%) of

Table 1 Distribution of dermatophyte and non-dermatophyte species from fungal cultures

Fungal	n	%
Dermatophyte		
<i>T. rubrum</i>	15	33.3
<i>T. mentagrophytes</i>	20	44.4
<i>T. violaceum</i>	2	4.4
<i>E. floccosum</i>	2	4.4
Non-Dermatophyte		
<i>Paecilomyces sp</i>	4	8.9
<i>Aspergillus niger</i>	1	2.2
<i>Aspergillus fumigatus</i>	1	2.2
Total	45	100.0

Table 2 Distribution of bacteria from bacterial cultures of dermatophytes

Bakteri	n	%
<i>S. aureus</i>	12	30.8
<i>S. epidermidis</i>	4	10.3
<i>B. subtilis</i>	3	7.7
<i>K. pneumoniae</i>	3	7.7
<i>K. oxytoca</i>	6	15.4
<i>E. coli</i>	5	12.8
<i>P. vulgaris</i>	1	2.6
<i>S. aureus</i> + <i>K. pneumoniae</i>	1	2.6
Bacterial growth (-)	4	10.3
Total	39	100.0

K. oxytoca a gram-negative rod and 5 specimens (12.8%) of *E. coli* (Table 2).

The result of the study showed *T. mentagrophytes* (43.6%) was the most species of dermatophyte found in the interdigital type of tinea pedis, followed by *T. rubrum* with 13 cases (33.3%). *T. rubrum* was found in 1 case with the vesiculobullous type of tinea pedis. 1 case of both *T. mentagrophytes* (2.6%) and *T. rubrum* (2.6%) were found in mixed interdigital and vesiculobullous types. *T. mentagrophytes* was found in 2 cases of mixed interdigital and hyperkeratotic types of tinea pedis from the fungal culture examination (Table 3).

The result of bacterial cultures in the interdigital type of tinea pedis showed *S. aureus* (28.2%) was the most species of bacteria, followed by *K. oxytoca* with 5 cases (12.8%), Mixed infections of *S. aureus* and *K. pneumoniae* with 1 case (2.6%) and 3 cases (7.7%) of no bacterial growth. *K. pneumoniae* was found in 1 case with the vesiculobullous type of tinea pedis. 1 case of both *E. coli* and *S. aureus* species was found in mixed interdigital and vesiculobullous types. *K. oxytoca* found in 1 case of mixed the interdigital and hyperkeratotic (Table 4).

DISCUSSION

The result in his study showed the number of female subjects was almost equal to the number of male subjects. In general, tinea pedis is most commonly found in males than females, possibly due to greater activity and exposure to trauma and humid/hot conditions.³ The largest age group in this study was 37-46 years old (28.9%), in accordance with the literature that mentions the most prevalence of tinea pedis was in adulthood and increases with age.³ In this age group of 37-46 years old is mainly active in work, so they are more exposed to the causes of disease including trauma and humid/hot conditions. Most subject occupations are housemaids (22.2%) who in their daily work are often in wet and humid conditions that facilitate the occurrence of fungal infections.

The most dermatophyte species in this study were *T. mentagrophytes* (44.4%), followed by *T. rubrum* (33.3%), *T. violaceum* (5.1%) and *E. floccosum* (5.1%) (Table 1). It accordance with the previous research by Tarigan in North Sumatra, Singapore, and Italy, The primary causal organisms of tinea pedis are *T. rubrum*, followed by *T. mentagrophytes* and *E. floccosum*.¹¹⁻¹³ The Difference results in species of fungi that have been found showed the differences of a geographical, climatical, and environmental factor.¹⁰ The most common bacterial culture results in this study were *S. aureus* a gram-positive coccus (30.8%), followed by *K. oxytoca* (15.4%), and *E. coli* (12.8%) (Table 2). Mainiadi in his study also found some bacterial species as secondary causes of infection in dermatophytosis with *S. aureus* was most commonly found (72.5%) followed by *S. epidermidis*, *Proteus*, and *E. coli*.¹⁴

According to previous studies, either normal or pathological toe are often colonized by significant amounts of bacteria, including the *Micrococcaceae* family (*staphylococci* and *micrococci*), aerobic diphtheroid bacteria (primarily lipophilic strains) and Gram-negative bacteria. In complex dermatophytosis, the fungus grew less frequently between macerated toes, but the prevalence of *S. aureus*, another Gram-positive bacteria, and Gram-negative bacteria, is significantly increased. In the condition of damaged stratum corneum, the pathogenic bacterial species will be induced inflammation and maceration process.⁶

In this study, the most common clinical features of tinea pedis encountered were interdigital types (88.9%). It accordance with many studies worldwide.^{1,2,3,10} Interdigital types of tinea pedis often involve bacterial superinfection in the progression of the disease.⁵⁻⁹ The result in this study showed *T. mentagrophytes* (43.6%) was the most species of dermatophyte found in the interdigital type of

Table 3 Distribution of Dermatophyte based on clinical type of tinea pedis

Dermatophyte	Tinea Pedis				Total (%)
	Interdigital (%)	Vesiculobullous (%)	Interdigital + vesiculobullous (%)	Interdigital + hyperkeratotic (%)	
<i>T. rubrum</i>	13 (33.3)	1 (2.6)	1 (2.6)	0 (0)	15 (38.5)
<i>T. mentagrophytes</i>	17 (43.6)	0 (0)	1 (2.6)	2 (5.1)	20 (51.3)
<i>T. violaceum</i>	2 (5.1)	0 (0)	0 (0)	0 (0)	2 (5.1)
<i>E. floccosum</i>	2 (5.1)	0 (0)	0 (0)	0 (0)	2 (5.1)
Total	34 (87.2)	1 (2.6)	2 (5.1)	2 (5.1)	39 (100)

Table 4 Distribution of bacterial species based on clinical type of tinea pedis

Bacteria	Tinea Pedis				Total (%)
	Interdigital (%)	Vesiculobullous (%)	Interdigital + vesiculobullous (%)	Interdigital + hyperkeratotic (%)	
<i>S. aureus</i>	11 (28.2)	0 (0)	1 (2.6)	0 (0)	12 (30.8)
<i>S. epidermidis</i>	4 (10.3)	0 (0)	0 (0)	0 (0)	4 (10.3)
<i>B. subtilis</i>	3 (7.7)	0 (0)	0 (0)	0 (0)	3 (7.7)
<i>P. vulgaris</i>	1 (2.6)	0 (0)	0 (0)	0 (0)	1 (2.6)
<i>K. pneumoniae</i>	2 (5.1)	1 (2.6)	0 (0)	0 (0)	3 (7.7)
<i>K. oxytoca</i>	5 (12.8)	0 (0)	0 (0)	1 (2.6)	6 (15.4)
<i>E. coli</i>	4 (10.3)	0 (0)	1 (2.6)	0 (0)	5 (12.8)
<i>S. aureus</i> + <i>K. pneumoniae</i>	1 (2.6)	0 (0)	0 (0)	0 (0)	1 (2.6)
Bacterial growth (-)	3 (7.7)	0 (0)	0 (0)	1 (2.6)	4 (10.3)
Total	34 (87.2)	1 (2.6)	2 (5.1)	2 (5.1)	39 (100)

tinea pedis, followed by *T. rubrum* (33.3%), also found *T. violaceum* (5.1%) and *E. floccosum* (5.1%) (Table 3). In the literature, the interdigital type can be caused by the three top species namely *T. rubrum*, *T. mentagrophytes* and *E. floccosum*. The hyperkeratotic type often caused by *T. rubrum* infection. The Infection of *T. mentagrophytes var interdigitale* varies in appearances from mild squama between toes until acute and severe inflammatory reactions on all parts of the foot. *T. mentagrophytes var interdigitale* was the primary causes of the vesiculobullous type, but there are also reports of *T. rubrum* infection. In addition to mild intertrigo, *E. floccosum* can cause vesicular infections on the sole, similar to typical *T. mentagrophytes var interdigitale* or hyperkeratotic conditions resembling *T. rubrum* infection.²

The result of bacterial cultures examination in interdigital type of tinea pedis showed *S. aureus* (28.2%) was the most species of bacteria were grown, followed by *K. oxytoca* (12.8%), mixed infections of *S. aureus* and *K. pneumoniae* (2.6%) and 7.7% of no bacterial growth (Table 4). It suggests, there is a role of Gram-positive bacteria in producing of clinical manifestations in the interdigital type

of tinea pedis, called complex dermatophytosis. But there are 7.7% cases with no bacterial growth, so in this condition of tinea pedis without bacterial involvement was called simplex dermatophytosis. According to Leyden et al., Simplex dermatophytosis is a pure fungal infection. When the toe area is excessively hydrated, microflora bacteria such as coccus and diphtheroid will overgrow manifested as a complex dermatophytosis (a collaboration between dermatophyte and bacterial infections).^{5,6} In the condition of severely complex dermatophytosis, Gram-negative organisms will be entered and aggravated the clinical manifestation of tinea pedis.^{5,6,15}

CONCLUSION

In this study, the most dermatophyte species found in tinea pedis were *T. mentagrophytes* followed by *T. rubrum*, *T. violaceum* and *E. floccosum* and the most common bacterial species were *S. aureus* followed by *K. oxytoca*, *S. epidermidis*, *E. coli*, *B. subtilis*, *K. pneumoniae* and *Proteus sp.* The role of dermatophyte and bacteria in clinical manifestation of tinea pedis have already known.

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