

## Clinical Investigations

# Yeasts of the genus *Candida* are the dominant cause of onychomycosis in Libyan women but not men: results of a 2-year surveillance study

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### Summary

**Background** The reported frequency of recovery of fungi from infected nails varies according to the geographical area.

**Objectives** To establish the nature of the causal agents in a sample of the Libyan population presenting with suspected onychomycosis.

**Methods** Samples were taken from the infected fingernails of 648 patients attending the Tripoli Medical Centre.

**Results** Samples from 500 patients proved positive for fungi following culturing, while 476 were potassium hydroxide and culture positive. Of the culture-positive samples, yeasts of the genus *Candida* (*C. albicans*, *C. parapsilosis*, *C. glabrata*, *C. guilliermondii* and *C. tropicalis*) were the dominant cause of this condition in women (417 of 434, 96%) but were responsible for only a minority of cases in men (three of 66, 5%). In contrast, dermatophytes (*Trichophyton violaceum*, *T. rubrum*, *T. mentagrophytes* and *Microsporum canis*) were responsible for this condition in the majority of cases in men (53 of 66, 80%) but only 3% (15 of 434) of cases in women. The mould *Aspergillus nidulans* was isolated from the nails of 10 (15%) men and two (0.5%) women.

**Conclusions** The data obtained in this study reveal an almost total separation of the aetiological agents responsible for onychomycosis based on gender.

**Key words:** *Candida*, dermatophytes, Libya, onychomycosis, *Trichophyton*

Onychomycoses (fungal infections of nail plates) are among the most frequent of nail diseases and represent 5.8–30% of diagnosed superficial mycoses.<sup>1</sup> As fungi have specific characteristics in their geographical distribution as well as in their predilection for different body sites,<sup>2</sup> the reported frequency of recovery of fungi from infected nails varies according to the geographical area and whether toenails or fingernails are being considered independently.<sup>1</sup> In temperate zones a higher prevalence of dermatophytes has been reported from both toenails and fingernails.<sup>3</sup> However, in tropical and subtropical countries, moulds such as *Aspergillus* species and *Fusarium oxysporum* have been reported as a

major cause of nail diseases.<sup>4</sup> In fingernails, *Candida* species can be isolated as frequently as dermatophytes.<sup>5</sup> The purpose of the present study was to establish the nature of the agents responsible for onychomycosis in a sample of the Libyan population presenting with suspected cases of disease.

### Materials and methods

#### *Patient population*

From August 1997 to December 1999, 648 patients (562 women and 86 men) with suspected fungal infection of the fingernails attending the Dermatology Clinic at Tripoli Medical Centre (TMC) were examined. All patients resided in the Tripoli area and were aged between 15 and 60 years (mean 30).

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*Sampling*

Fingernail scrapings and clipping fragments of infected nails were collected and processed as recommended.<sup>1,2</sup> Each patient was sampled on two independent occasions, usually a week apart, to exclude the possibility of non-specific colonization of the sample site by *Candida* species and to confirm that the isolated fungi were not environmental contaminants. There was a very high return (> 95%) of patients for the second sampling because medication was dispensed at this visit. In all cases fungi were identified from both samplings and results agreed. The fungi isolated from the first visit were routinely used in subsequent work.

*Fungal identification*

Direct microscopic examination was performed using 20% (w/v) potassium hydroxide (KOH). A portion of specimen was placed on a microscopic slide and 50 µL of KOH was added. After 15 min, the wet preparation was examined for the presence of fungal elements and their diagnostic morphology such as arthroconidia, hyphae, yeast cells or combinations of these. Samples were also cultured on duplicate plates of Sabouraud chloramphenicol (BioMérieux, Marcy-l'Étoile, France) made according to the manufacturer's instructions. The plates were inoculated with finely divided pieces of each sample and incubated at 25 °C for recovery of dermatophytes or moulds.

Plates for the recovery of *Candida* species were incubated at 37 °C, examined twice weekly for evidence of growth and maintained for up to 4 weeks before being discarded as negative. *Candida* species were first identified using the API 20C AUX commercial system (BioMérieux). All *C. albicans* isolates were tested for germ tube production in human serum as well as for chlamyospore formation on corn meal agar plus Tween 80 (Sigma Chemical Co., Poole, U.K).

Fungal isolates were subcultured on to Sabouraud and potato dextrose agar (Oxoid, Basingstoke, U.K). The isolates were examined macroscopically and microscopically in lactophenol-cotton blue. The dermatophyte species were identified by gross and microscopic morphology and by *in vitro* tests, if required, based on criteria enumerated previously.<sup>6,7</sup> Identification of moulds as pathogens was based on an examination of morphology and microscopic structures following growth on Czapek's agar medium according to the scheme detailed by Raper and Fenell.<sup>8</sup>

**Results**

Of the 648 patients with suspected fungal infection of the fingernails, 500 proved culture positive for fungi. Women accounted for 434 (86.8%) of these patients, and 66 (13.2%) were men. Patients in the age range 20–30 years represented the majority of cases (375 cases, 75%). The yeast *C. albicans* was the most common cause of fingernail infection in this patient sample and was isolated in 252 (50.4%) cases (Table 1). In total, yeasts of the genus *Candida* were responsible for 420 cases (84%) of infection, the vast majority (417) in women (Table 1). Dermatophytes were isolated in 68 cases (13.6%) and the mould *A. nidulans* was found in 12 cases (2.4%), 10 of which were from men. In women yeasts of the genus *Candida* were the dominant cause of fingernail infection whereas in men the dominant causes were *Trichophyton violaceum*, *T. rubrum*, *Microsporum canis*, *A. nidulans* and *T. mentagrophytes*. The range of species responsible for this condition in women was almost totally distinct from that responsible for the condition in men.

Samples from 476 of 500 patients (95.2%) were positive by microscopic examination following KOH treatment and by culture growth. Samples from 24 patients were KOH negative but culture growth positive (*C. albicans* 12 isolates, *C. parapsilosis* three isolates, *C. glabrata* two isolates and one each from the remaining fungi listed in Table 1). Microscopic examination of KOH-treated samples revealed yeasts or yeasts and hyphae in the majority of cases (401 of 476, 84.2%), hyphae alone in 42 cases (8.8%) and hyphae and arthroconidia or arthroconidia alone in 33 cases (6.9%) (Table 2).

**Table 1.** Distribution of fungi responsible for onychomycosis according to gender (numbers represent all patients culture-positive for fungi)

Species	Women	Men	Total number of isolates (%)
<i>Candida albicans</i>	249 (57.3%)	3 (4.5%)	252 (50.4%)
<i>Candida parapsilosis</i>	72 (16.6%)	0	72 (14.4%)
<i>Candida glabrata</i>	40 (9.2%)	0	40 (8.0%)
<i>Candida guilliermondii</i>	40 (9.2%)	0	40 (8.0%)
<i>Candida tropicalis</i>	16 (3.7%)	0	16 (3.2%)
<i>Trichophyton violaceum</i>	8 (1.8%)	20 (30%)	28 (5.6%)
<i>Trichophyton rubrum</i>	5 (1.1%)	15 (22.7%)	20 (4.0%)
<i>Microsporum canis</i>	2 (0.5%)	10 (15.1%)	12 (2.4%)
<i>Aspergillus nidulans</i>	2 (0.5%)	10 (15.1%)	12 (2.4%)
<i>Trichophyton mentagrophytes</i>	0	8 (12.1%)	8 (2.1%)
Total isolates	434	66	500

*C. albicans* was responsible for 47% (68 of 144) of cases of single fingernail infection followed in descending order by *C. glabrata* (24%, 35 of 144), *C. parapsilosis* (11%, 16 of 144), *C. guilliermondii* (9%, 13 of 144) and *C. tropicalis* (8%, 12 of 144) (Table 3). In the case of infection of two nails or where fingernails on both hands were affected, again the dominant fungus was *C. albicans*, responsible for 45% (21 of 46) and 54% (141 of 262) of infections, respectively. The vast majority of *Candida* species-induced cases of onychomycosis occurred in women (Table 1). Dermatophytes were not identified as being responsible for infections in cases of single or double nail infection. Where dermatophytes or *A. nidulans* were implicated in disease, either all 10 fingernails or more than two fingernails on both hands were involved (Table 3), mostly in men (Table 1).

## Discussion

Fungal infections of fingernails accounted for 17% of all superficial mycoses among patients attending the outpatient Dermatology Clinic at TMC. In this study, a higher frequency of fingernail infections was demonstrated in women than in men. Several studies have found similar results, especially in temperate zones.<sup>5,9</sup> However, others have reported no notable difference,<sup>8</sup> while some investigators found fungal infection of

fingernails to be more common in men than women.<sup>10</sup> The reason for the greater frequency of fungal infection of fingernails among women is probably due to the frequent immersion of the hands in water or exposure to chemicals and trauma.<sup>11</sup> In addition, women are more concerned about the appearance of their fingernails than men. Onychia and paronychia due to *Candida* species, particularly *C. albicans*, were the most common clinical forms observed in this study and accounted for 84% of culture-positive cases, most of which were in women aged between 20 and 30 years. Previous reports have indicated that dermatophytes are the dominant cause of onychomycosis<sup>3</sup> but the findings of this survey indicate that in women, yeasts of the genus *Candida* are the principal aetiological agents of this condition. Our findings agree with other surveys which found that *Candida* onychia is usually seen more often in women than men.<sup>3,5</sup> Other *Candida* species, particularly *C. parapsilosis*, *C. glabrata* and *C. guilliermondii*, were isolated more frequently from women who presented with chronic paronychia or onycholysis. This finding confirms early reports that found the prevalence of these yeasts to be higher in fingernail infections.<sup>5,12</sup> Of the men presenting with fingernail infection, only three showed *C. albicans*. Onychomycosis of the fingernails due to dermatophytes was higher among men (53 cases) than women (15 cases). The

**Table 2.** Results of microscopic examination of samples that were microscopy and culture positive

Infected fingernail(s)	Number of patients	Y	Y & H	H	H & Arth	Arth
One hand infected						
Right middle finger or thumb	144	127	17	0	0	0
More than one fingernail	46	14	32	0	0	0
10 fingers infected	24	2	8	2	0	12
Fingernails of both hands infected	262	6	195	40	14	7
Total number	476	149	252	42	14	19

Y, yeasts; H, hyphae; Arth, arthroconidia.

**Table 3.** Fungi responsible for onychomycosis of different fingernail groupings in samples that were microscopy and culture positive

Fungus isolate	Single nail	Two nails	10 nails	Both hands
<i>Candida albicans</i>	68	21	10	141
<i>Candida parapsilosis</i>	16	15	0	38
<i>Candida glabrata</i>	35	3	0	0
<i>Candida guilliermondii</i>	13	4	0	22
<i>Candida tropicalis</i>	12	3	0	0
<i>Trichophyton violaceum</i>	0	0	5	22
<i>Trichophyton rubrum</i>	0	0	5	14
<i>Microsporum canis</i>	0	0	0	11
<i>Aspergillus nidulans</i>	0	0	2	9
<i>Trichophyton mentagrophytes</i>	0	0	2	5
Total isolates (n = 476)	144	46	24	262

anthropophilic fungi *T. violaceum* and *T. rubrum* were isolated more frequently from men than women. Previous epidemiological surveys have found that *T. rubrum* and *T. mentagrophytes* are responsible for most cases of dermatophyte-induced onychomycosis of the fingernails.<sup>13,14</sup> The reason for the higher prevalence of *T. violaceum* in this study may be because this fungus was found to be the most commonly isolated dermatophyte species from patients with tinea capitis or tinea corporis in Libya (Ellabib, Refai & El-Gamodi, unpublished observation). Onychomycosis due to non-dermatophyte fungi accounted for only 2.4% of all fingernail infections; *A. nidulans* was the only fungus isolated, mainly from men. Similar studies have found that non-dermatophyte-induced onychomycosis, particularly in temperate regions, accounts for less than 3% of isolates, even in large surveys.<sup>15,16</sup>

In conclusion, this study has demonstrated that yeasts of the genus *Candida* are the dominant cause of onychomycosis in Libyan women but that dermatophytes are the principal cause of this condition in men. The reason for this may lie in the different types of trauma (e.g. immersion in water, exposure to chemicals) experienced by the fingernails of men and women and also whether the patients suffer from a concurrent dermatophyte infection such as tinea capitis or tinea corporis. There also appears to be a greater tendency among women to present with this condition in comparison with men. The data presented here indicate that in women the condition is caused by yeasts of the genus *Candida* and that one or two fingernails on one or both hands tend to be infected, while in men the condition is caused almost exclusively by dermatophytes or *A. nidulans* and that either more than two fingernails on each hand are infected or all 10 fingernails are involved. To the best of our knowledge, this is the first occasion on which an almost complete

separation, based on gender, of aetiological agents responsible for onychomycosis has been observed.

## References

- 1 Midgley G, Moore MK, Cook C, Phan QG. Mycology of nail disorders. *J Am Acad Dermatol* 1994; **31**: 68–74.
- 2 Denning DW, Evans EGV, Kibbler CC *et al*. Fungal nail disease: a guide to good practice. *Br Med J* 1995; **311**: 1277–81.
- 3 Aly R. Ecology and epidemiology of dermatophyte infections. *J Am Acad Dermatol* 1994; **31**: 21–5.
- 4 Clayton YM. Clinical and mycological diagnostic aspects of onychomycoses and dermatomycoses. *Clin Exp Dermatol* 1992; **17** (Suppl. 1): 37–40.
- 5 Naidu J. Growing incidence of cutaneous and unguinal infections by non-dermatophyte fungi at Jabalpur, India. *Indian J Pathol Microbiol* 1993; **36**: 113–18.
- 6 Staats CC, Kortanje MJ. Fungi causing onychomycosis in the Netherlands. *Ned Tijdschr Geneesk* 1994; **138**: 2340–3.
- 7 Fisher F, Cook N. *Fundamentals of Diagnostic Mycology* Philadelphia: W.B.Saunders Company, 1998.
- 8 Raper KB, Fennell DI. *The Genus Aspergillus*. Baltimore: Williams & Wilkins, 1965.
- 9 Frey D, Oldfield R, Bridger R. *A Colour Atlas of Pathogenic Fungi*. London: Wolfe Medical Publications Ltd, 1985.
- 10 Roberts DT. Prevalence of dermatophyte onychomycosis in the United Kingdom: results of an omnibus survey. *Br J Dermatol* 1992; **126** (Suppl. 39): 23–7.
- 11 Watanabe S, Seki Y, Shimozuma M, Takizawa K. Nail candidiasis. *J Dermatol (Tokyo)* 1983; **10**: 189–203.
- 12 Sais G, Jucgla A, Peyi J. Prevalence of dermatophyte onychomycosis in Spain: a cross-sectional study. *Br J Dermatol* 1995; **132**: 758–61.
- 13 Frain-Bell W. Chronic paronychia. Short review of 590 cases. *Trans St Johns Hosp Dermatol Soc* 1957; **38**: 29–30.
- 14 Canteros GE, Davel GO, Vivot W. Casual agents of onychomycosis. *Rev Argent Microbiol* 1994; **26**: 65–71.
- 15 Lim JT, Chua HC, Goh CL. Dermatophyte and non-dermatophyte onychomycosis in Singapore. *Australas J Dermatol* 1992; **33**: 159–63.
- 16 Summerbell RC, Kane J, Krajdien S. Onychomycosis, tinea pedis and tinea manuum caused by non-dermatophytic filamentous fungi. *Mycoses* 1989; **32**: 609–19.