

Evaluation of Fungal Infections in Burn Patients at Ali-ebn AbiTalib Hospital in Zahedan

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Abstract

Background: Burns are the leading cause of disability and mortality in the world, which has led to serious economic and social consequences.

Objectives: The present study aimed to investigate fungal infections in burn patients admitted to Ali-ebn Abitalib Hospital in Zahedan.

Methods: This study was conducted from April 2023 to October 2023. The research population was 113 burn patients admitted to Ali-ebn Abitalib Hospital. Data was collected by recording demographic data, sampling lesions suspected of fungal infection, and laboratory tests. All samples were recognized using phenotypic methods such as microscopy and culture on Sabouraud dextrose agar with chloramphenicol. The data was analyzed using SPSS software version 26.

Results: About 13.3% of the studied burn patients had a positive fungal culture. The most common fungus grown in burn patients was *Candida albicans/C. dubliniensis* (46.6%), *Aspergillus niger* species complex (40%), *Fusarium* spp. (13.3%) Furthermore, *Aspergillus fumigatus* species complex (13.3%) and the prevalence of other species was less than 10%. It was also found that positive fungal culture in burn patients is directly related to age, high percentage of burns, and length of hospitalization.

Conclusion: Considering the high prevalence of fungal infection in burn patients and the identification of influential risk factors, all patients should be examined for fungal infection.

Keywords: Burn, Fungal infection, Outbreak

1. Background

Burn is one of the injuries to the epidermis and dermis, which destroys soft tissues and organs of the body. According to the World Health Organization (WHO),

trauma is known as the second cause of hospitalization, and on the other hand, burns are one of the most common causes of trauma (1). In the reports of this organization, burns are defined as a global health problem, and the prevalence of

burns in developing countries is seven times higher than in underdeveloped countries. Also, throughout the year, many people suffer from burns. Many of them need to be admitted to the hospital because the skin is the most crucial protective barrier against the entry of microorganisms into the body. Loss of skin due to burns requires immediate action to maintain its function. In addition, this problem causes a lot of medical expenses and complications, and it can plague patients for years (1, 2).

In recent decades, the life expectancy of burn patients has increased due to fluid therapy methods, nutritional support for patients, surgery at the most appropriate time after resuscitation from burn shock, and treatment of burn wound infection at a suitable time and with the proper antibiotic regimen (3). However, despite significant advances in the care of burn patients, complications from burn wound infection (BWI) are the leading cause of wound infections in burn intensive care units, which today have become a public health problem and one of the most devastating injuries (4). Patients with burns due to the creation of a nutritious environment rich in proteins, the loss of skin defense immunity, inhibition of the immune system, severe burns to a large extent, and long-term hospitalization in the burn areas are more likely to lead to microbial colonization and the occurrence of Recurrent infections are induced (5,6). The tissues inside the burn wound lack life and blood vessels. Therefore, polymorphonuclears, antibodies, and systemic antibiotics cannot penetrate them; in this way, the conditions inside the wound are ready for the growth of saprophytic fungi such as *Candida*, *Mucor*, *Rhizopus*, *Penicillium*, and *Aspergillus* species. The primary sources of infection are the natural flora of the skin and digestive system of the sick person, and the surrounding environment is also an important secondary source. Most of these

microorganisms are present in the hospital environment, especially in burn areas, and due to the defect of the patient's immune system, they appear as opportunistic pathogens (7). Regularly, the infection in burn patients is caused mainly by bacteria, fungi, and then viruses (8). However, for reasons such as the presence of fungal agents and their variety, early surgery, and extensive use of antibiotics, diagnosis and treatment of burn patients with fungal infections have become an increasing problem in the past few years. In this regard, invasive fungal infections have also increased in patients with burn wounds (9). Since saprophytic fungi can colonize burnt tissues more than other organisms due to their prevalence in the air, they lead to infection, complications, and death in burn patients (10). The presence of fungi in the surrounding environment of the patient, disruption in the function of the skin defense barrier and the natural and acquired immune system, as well as the widespread use of antifungal drugs (fungal resistant species including *Candida albicans* species, *Aspergillus* and *Mucorales*) make burn patients susceptible to dangerous and deadly fungal infections (5). According to the mentioned cases and the change of infection risk factors over time, the knowledge of fungal agents to control the spread of infection in the wounds of burn patients, and the need to use preventive treatments, Infected wounds should be considered as potential sources of risk and the sensitivity pattern of these agents should be determined in each burn section. Consequently, regarding the high prevalence and mortality of fungal infections in burn patients, it is necessary to investigate the frequency of opportunistic fungi in burn wounds (11). Considering the fungal diseases in hospital environments, the mentioned issues, and the lack of

comprehensive research at Zahedan University of Medical Sciences, the study investigated fungal diseases in hospitalized patients.

2. Objectives

The present study aimed to determine burn wound fungi in patients hospitalized in Ali-ebn Abitalib Zahedan Hospital in 2023.

3. Methods

This study was conducted for six months (April 2023 to October 2023) on 113 patients with burns hospitalized in Ali-ebn Abitalib Zahedan Hospital in 2023. The study inclusion criteria were all burn patients between 18-60 years, patients hospitalized within seven days after the burn injury, and pregnant and lactating women, and patients who were taking antifungal drugs were excluded from the study. A convenience sampling method was used. In order to collect data, demographic characteristics, degree, and percentage of burns were collected, lesions suspected of fungal infection were sampled, and direct examination and culture techniques were used. After obtaining written informed consent from the patients, wet samples were prepared with two sterile swabs dipped in PBS from the patient's wound secretions and placed in sterile test tubes. It was also collected from the scabs of the patients' wounds. The samples were transferred to the mycology laboratory of Bu Ali Zahedan Hospital. In the first step,

direct microscopic examination and culture were used and evaluated for infection reorganization, considering the presence of hyphae, yeast, pseudohyphae, and fungal spores. The sample was recorded as positive if yeast cells and mycelia were observed. The second swab with wound secretions or crusts was cultured in Sabouraud Dextrose Agar (SDA) with chloramphenicol incubation at 25-30°C for 4-7 days in 2 series were performed. Media were checked daily for fungal colonies. All samples were examined for microscopic (shape, size, and location of spores) and macroscopic characteristics. Chi-square and Fisher's statistical analyses were performed using SPSS version 26 software.

4. Results

The average age of the patients was 30.88 ± 7.38 years (15 to 54 years). Regarding gender, 56 patients (49.6%) were male and 57 (50.4%) were female. Also, four patients (3.5%) in the first culture, 12 patients (10.6%) in the second culture, and nine patients (8%) in the third culture had fungal infection. In general, 15 patients (13.3%) had positive fungal cultures, as seen in Table 1. The most common fungi isolated from patients with burns are *Candida albicans/C. dubliniensis* (46.6%) and *Aspergillus niger* species complex (40%), *Fusarium* spp. (3 13.0%) Moreover, *Aspergillus fumigatus* species complex (13.3%) and the prevalence rate in other species was less than 10%.

Table 1. The frequency of fungi in burn patients hospitalized in Ali-ebn Abitalib Hospital

Fungi/Fungus	Frequency	Percentage (%)
<i>Candida albicans/C. dubliniensis</i>	7	46.6
<i>Aspergillus niger</i> species complex	6	40
<i>Fusarium</i> spp.	2	13.3
<i>Aspergillus fumigatus</i> species complex	2	13.3
<i>Mucor</i> spp.	2	6.7
<i>Aspergillus flavus</i> species complex	2	6.7

The average age of patients with positive fungal cultures (37.4) was significantly higher than patients with negative cultures (29.89) ($P < 0.05$). The frequency of positive cultures in

burn patients older than 30 years was significantly higher (20.3%) than in patients younger than 30 years ($P < 0.05$) (Table 2).

Age Culture		Lower 30year	Upper 30 year	Total	OR (CI 95%)	P value
Negative	number	47	51	98	5.99 (1.28-27.95)	0.012
	Percent	95.9%	79.7%	86.7%		
Positive	number	2	13	15		
	Percent	4.1%	20.3%	13.3%		
Total	number	49	64	113		
	Percent	100.0%	100.0%	100.0%		

In Table 3, the frequency of burn wound culture results of patients based on gender did not show a statistically significant difference,

as 7 cases in males and 8 cases in females had positive cultures.

Sexuality and Culture		male	female	Total	OR (CI 95%)	P-value
Negative	number	49	49	98	1.14 (0.38-3.39)	0.81
	Percent	87.5%	86.0%	86.7%		
Positive	number	7	8	15		
	Percent	12.5%	14.0%	13.3%		
Total	number	56	57	113		
	Percent	100.0%	100.0%	100.0%		

The average percentage of burns in patients with positive fungal cultures (40.33%) was significantly higher than in patients with negative cultures (21.95) ($P < 0.001$). In Table 4, the frequency of positive cultures in patients

with burns with a percentage more significant than 30% was significantly higher than in patients with a percentage of burns less than 30% ($P < 0.001$).

Percentage culture		less than 30%	More than 30%	Total	OR (CI 95%)	P-value
Negative	number	69	29	98	15.46 (3.28-72.9)	<0.001
	Percent	97.2%	69.0%	86.7%		
Positive	number	2	13	15		
	Percent	2.8%	31.0%	13.3%		
Total	number	71	42	113		
	Percent	100.0%	100.0%	100.0%		

The average length of hospitalization in patients with positive fungal cultures was

significantly higher than in patients with negative cultures ($P < 0.001$) (Table 5).

variable	Culture result	number	mean	S.D.	P-value
length of hospitalization	positive	15	8.07	3.674	0.001
	negative	98	4.34	1.674	

As shown in Table 6, the frequency of positive culture in patients with burns and a hospitalization period of more than seven

days was significantly higher than in patients with a hospitalization period of less than seven days (P=0.001).

Table 6. The frequency of fungal culture results in burn patients based on the length of hospitalization

length of hospitalization culture		Less than seven days	More than 7 days	Total	OR (CI 95%)	P-value
Negative	number	86	12	98	6.27 (1.92-20.41)	0.001
	Percent	91.5%	63.2%	86.7%		
Positive	number	8	7	15		
	Percent	8.5%	36.8%	13.3%		
Total	number	94	19	113		
	Percent	100.0%	100.0%	100.0%		

5. Discussion

Invasive fungal wound infection (FWI) after burn injury has significant morbidity and mortality. Early identification, diagnosis, and treatment are required to optimize patient survival (12). The present study aimed to investigate fungal infections in burn patients hospitalized in Ali-ebn Abitalib Zahedan Hospital in 2023. Samples were taken from 113 burn patients, and the findings showed that 15 people (13.3%) had positive fungal cultures, and the most common fungi isolated from burn patients were *Candida albicans*/C. *daublinensis* (46.6%), *Aspergillus niger* complex species (40%), *Fusarium* spp. (13.3%) and *Aspergillus fumigatus* species complex (13.3%). Other species occurred less than 10%. Comparable results also indicate many risk factors related to the environment, patient, and treatment for causing fungal infections; for example, uncontrolled temperature and humidity can cause fungal infections. Similarly, in old age, a higher percentage of total body surface area (TBSA) of burn wounds and inhalation injury also causes fungal infection (12-14), which aligns with the present study's findings. The current study also found that the older age and higher burn percentage of patients are associated with more fungal infections in patients. Of course, it should be mentioned that neutropenia and

immunocompromised patients, such as those with diabetes, cause fungal infections in burn wounds (15, 16), which were not investigated in the present study, and it is recommended to be carefully investigated in future studies. Fungal invasion of burn wounds can be fungal wound infection (FWI), the fungal invasion of living tissue, and fungal colonization, an invasion of nonviable fungal elements in burned skin. Furthermore, the classification of fungal status depends on the deepest histological level of invasion (17). Other evidence suggests that most infections are incorrect diagnoses due to lack of clinical awareness, similarity to bacterial infections, and lack of mycology laboratory infrastructures. As documented in studies, fungal infection ranges from 6.3% to 44% in reports from various burn centers worldwide (18). In the present study, the prevalence of fungal infection was estimated to be 13.3%, which is low compared to the stated range. However, it still has a significant prevalence and requires careful investigation for early diagnosis and providing the basis for improving the treatment status of patients. In a similar study conducted by Moussa et al., fungal infection was evaluated in 130 burn patients, and 30 fungal isolates were recorded in 26 patients, with an incidence of 20% (19). Also, in a multicenter trial, the American Burn Association analyzed 6918 patients, and the research results showed

that 435 people (6.3%) had a positive fungal culture (12). The present study's relatively high incidence of fungal infections may be attributed to hospital and endemic factors. *Candida* wound infection, with a prevalence of 13 to 31.8%, has become the main cause of death in burn patients. However, the epidemiology of fungi shows variable trends with the isolation of non-*albicans* species of *Candida*, *Aspergillus*, *Fusarium*, and *Zygomycetes*, which are more aggressive and resistant to common antifungals (19-21). The present study showed that the prevalence of fungal infections were *Candida albicans* (46.6%), *Aspergillus niger* (33.3%), *Fusarium* spp. (13.3%) and *Aspergillus fumigatus* (13.3%), respectively. Other studies have determined that *Candida albicans* have the highest prevalence, and they emphasize the dominance of *Candida albicans* in fungal burn wound infection (22-25). In this research, there was a significant relationship between the occurrence of fungal infections and the percentage of burns. In a study performed by the American Burn Association on 6918 burn patients, 435 patients with fungal BWI, the burn rate was $34.8 \pm 22.7\%$, which had a significant relationship with the burn rate (12). This was following the study of Brooke et al., who observed the highest number of positive fungal cultures (46.9%) in patients with burns of 30-59% of the body surface (22). The outcomes of other studies indicate that the high prevalence of fungal infections is related to the increase in the body's level of burns in immunocompromised patients with high degrees of burns. Furthermore, in the present study, fungal infections were associated with a prevalence of 50% in patients with fourth-degree burns, 16.3% in third-degree burns, and 3.2% in second-degree burns. These results are in accordance with the study conducted by Brooke et al. They reported that fungal infections were 16.7% in second-degree burns and 58.8% in third and fourth-degree burns (14). Other findings revealed that the

duration of hospitalization is more related to the high prevalence of fungal infection, which agrees with the findings mentioned by Brooke et al. They started the colonization of the burn wound with fungi and yeast, which increased after the first week, with the peak incidence in the third and fourth week of the burn (22). The results of another similar study conducted by Ibrahim et al. on 66 burned patients concluded that at the end of the second week after the burn, fungi caused the invasion of the burn wound (23). Overall, the most common fungi grown in burn patients were *Candida albicans*/*C. dubliniensis*, *Aspergillus niger* species complex, *Fusarium* spp., and *Aspergillus fumigatus* species complex, respectively. It was also found that there is a direct correlation between positive culture of fungi in patients with age, high percentage of burns, and length of stay in the hospital.

6. Conclusion

Considering the high prevalence of fungal infections in burn patients and the identification of effective risk factors, suspected patients should be examined for fungal infection, and appropriate treatment should be provided to patients in the shortest possible time to improve the quality of treatment. Reducing the length of stay in the hospital and early discharge from the hospital should also be taken into account by healthcare managers.

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Consent for publication: Not applicable.

Ethics approval and consent to participate:

The current research is taken from the thesis approved in Zahedan University of Medical Sciences. All the experimental procedures in this study were approved by the Vice-Chancellor of Zahedan University of Medical Sciences of Iran, Zahedan (ethical code: IR.ZAUMS.REC.1401.385). The study was conducted in accordance with the principles of the Helsinki Declaration and written Informed Consent was obtained from all subjects.

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