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Clinical and Microbiological Characteristics of Hand Infection in Female Patients with Diabetes Attending University in Qassim, Saudi Arabia

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Abstract

Background: Hand infection in diabetics is a well-known problem which results in high morbidity and occasional mortality. **Patients and methods:** 182 cases of hand infection were collected from the Qassim University over the past two years. 114 diabetic female patients, of any type (1, 2), were included in this study. Clinical examination and culture were done. Different media were used for the isolation of aerobic, anaerobic and yeast. **Results:** *E. coli* was the most prevalent organism in diabetic patients. The isolates that were observed in decreasing order of frequency, in diabetic patients, were *E. coli*, *S. aureus*, *Streptococcus* beta hemolytic, *Pseudomonas aeruginosa*, *Proteus* sp., *Streptococcus viridans*, *Enterobacter*, anaerobes and yeast (*Candida*). In the control cases we found *S. aureus* in high percentage followed by Coagulase negative *Staphylococcus*, *Enterococcus* and *E. coli*, *Streptococcus* beta hemolytic, *P. aeruginosa*, anaerobes and in low percentage *K. pneumonia* and *Enterobacter*. **Conclusions:** This study demonstrates

bacterial composition of diabetic's hand flora predominated by Gram negative organisms. The presence of anaerobes, and fungi is noted.

Key words: Hand abscess, Paronychia, Diabetes, *E. coli*, *S. aureus*, Infection.

Introduction

During the last decade, there has been decreasing interest in the diabetic hand, and it is the authors' impression that most clinicians tend to ignore it (1). The manifestations of diabetes in the hand were much highlighted in the 1970s and 1980s (1). The term "diabetic hand" was coined to describe what was then thought to be the complications of diabetes mellitus in the hand, primarily limited joint mobility or stiff hand (1). Immuno-compromised patients are at higher risk of serious hand infections, including atypical, digit and life-threatening infections (2). The hand is the major prehensile organ; it is constantly in use and

at risk of injury and infection (3). The outcome of a hand infection is related to how early it is diagnosed and initially treated (4). The compact nature of the hand allows infection to spread and cause damage rapidly (5). Hand ulceration and infection in diabetic patients was first described in the United States in 1977 and in Africa in 1984 (6). It is firstly important to appreciate that the etiology of diabetic hand disease is truly multifactorial (7). Within any individual patient one factor may predominate over all or some of the others, but generally the hand disease arises from more than one cause (7). Traumatic wounds, particularly with significant soft tissue damage, increase the risk of infection. Foreign material of any kind will also provide a nidus for infection (2). Gram-positive aerobes make up the vast majority of organisms cultured from hand infections (5). Staphylococcal infections are most common (4) but a wide variety of other micro-organisms may be involved, either individually or as a polymicrobial type of infection including Gram-negative organisms such as *Enterobacter*, *Streptococcus*, *Pseudomonas aeruginosa*, anaerobes and fungal organisms (4). Gram-positive aerobes make up the vast majority of organisms cultured from hand infections (8). Methicillin-resistant *Staphylococcus aureus* (MRSA) has emerged as the most commonly cultured bacteria in hand infections (9). Fungal infections in the hand can range from simple cosmetic infection of the nails to life-threatening deep space infections (10). Viral infections are uncommonly responsible for clinically significant infections of the hand. However, relatively few species are known to cause infections of the hand. These include members of the papillomaviridae family (human papillomavirus), herpesviridae family (herpes simplex virus), picornaviridae family (coxsackievirus and enterovirus), and poxviridae family (orthopoxvirus and parapoxvirus) (11).

Patients and Methods

Objectives

The aim of the study was to explore the prevalence of bacteria and clinical characteristics of diabetic hand infection in women from Qassim University, Saudi Arabia.

Patients

182 female patients from Qassim University over two years 111 were involved in this study. Among them, 114 patients suffering from diabetes of either type (type 1 diabetes (T1DM) or type 2 diabetes (T2DM) and 68 were controls. The patients were classified according to the presence of hand infection. 27 patients with superficial lesions, 11 patients had paronychia (minor abscesses), 2 patients had

hand abscess (serious abscesses) and 9 patients had hand ulcer and 65 patients with normal hand (no infection). Controls were 68 non diabetic patients [56 patients without any hand infection and 12 patients with superficial lesions]. A detailed history was taken from each patient and a careful clinical examination of the involved hand was performed (7). Also, the patient's profession and hobbies determine the required level of hand function and possible sources of infection. Careful observation of hand and finger position, skin colour and swellings on either the palmar or dorsal surfaces should guide more focused examination (2). Among the diabetic's patients, we recorded 101 patients ranging from 18 years to 24 years old and 13 patients from 25 years to 54 years old. 62 patients had diabetes mellitus for less than 5 years duration, 23 patients between 6-10 years and 29 patients for more than 10 years duration. Diagnosis of diabetes was according to accepted criteria (7).

Sampling

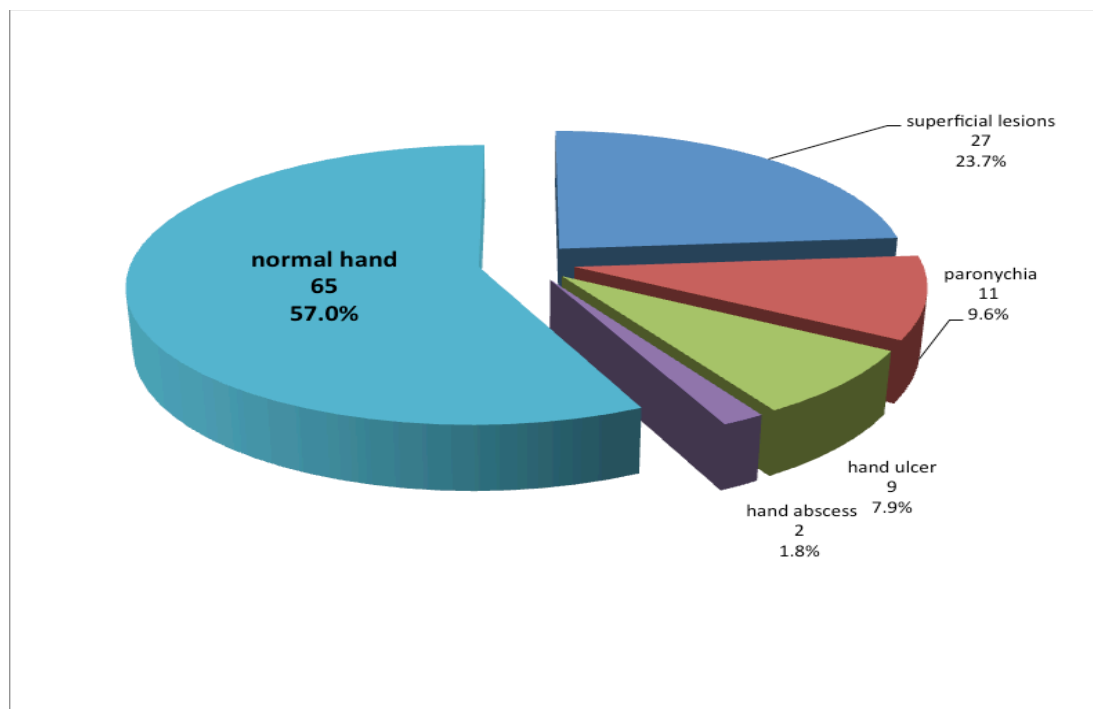
Specimens were processed within 2 h of sampling. A sterile swab was taken from various location of hand. Samples were collected and placed in the brain-heart broth for enrichment, and incubated for 2-4 h.

Bacteriological studies

Gram smear was done for each of the specimens. All specimens were analyzed and grown in appropriate culture media (12). Culture was also performed to detect aerobic and anaerobic bacteria. Loop full of inoculated brain heart infusion were cultured on blood agar and kept in anaerobic jar to supply anaerobic condition, another loop full were streaked on blood agar, mannitol salt agar, Mac Conkey agar and Sabouraud agar. Plates were incubated in aerobic condition for 24-48 h in 37°C. The bacterial isolates were identified by conventional biochemical tests. Classification and identification of aerobic and anaerobic were done according to standard routine techniques proposed by Forbes et al. (13). Aerobic culture on Mac Conkey agar allowed us to identify Gram negative bacilli. Culture on blood agar incubated aerobically led to the identification of *Streptococci* (*Streptococcus* beta hemolytic and *S. viridans*). Similarly, *S. aureus* was cultured on blood agar and mannitol salt agar. Culture on anaerobic blood agar identified some anaerobic bacteria. Finally, Sabouraud agar allowed the isolation of *Candida*.

Table 1. Frequency of organisms isolated on culture

Organisms	Diabetic hand		Non-diabetic hand	
	N	%	N	%
<i>S. aureus</i>	44	15.6 %	58	37.7 %
<i>S. epidermidis</i>	-	-	24	15.6 %
<i>Strept Beta hemolytic</i>	34	12.1 %	8	5.2 %
<i>S. viridans</i>	20	7.1 %	-	-
<i>Enterococcus</i>	-	-	18	11.7 %
<i>Pseudomonas</i>	30	10.6 %	8	5.2 %
<i>E. coli</i>	94	33.3 %	18	11.7 %
<i>K. pneumoniae</i>	-	-	6	3.9 %
<i>Klebsiella sp</i>	-	-	4	2.6 %
<i>Proteus</i>	22	7.8 %	-	-
<i>Enterobacter</i>	16	5.7 %	4	2.6 %
<i>Anaerobes</i>	14	5 %	6	5.2 %
<i>Candida</i>	8	2.8 %	-	-

**Figure 1.** The types of infection diagnosed are listed in order of frequency.

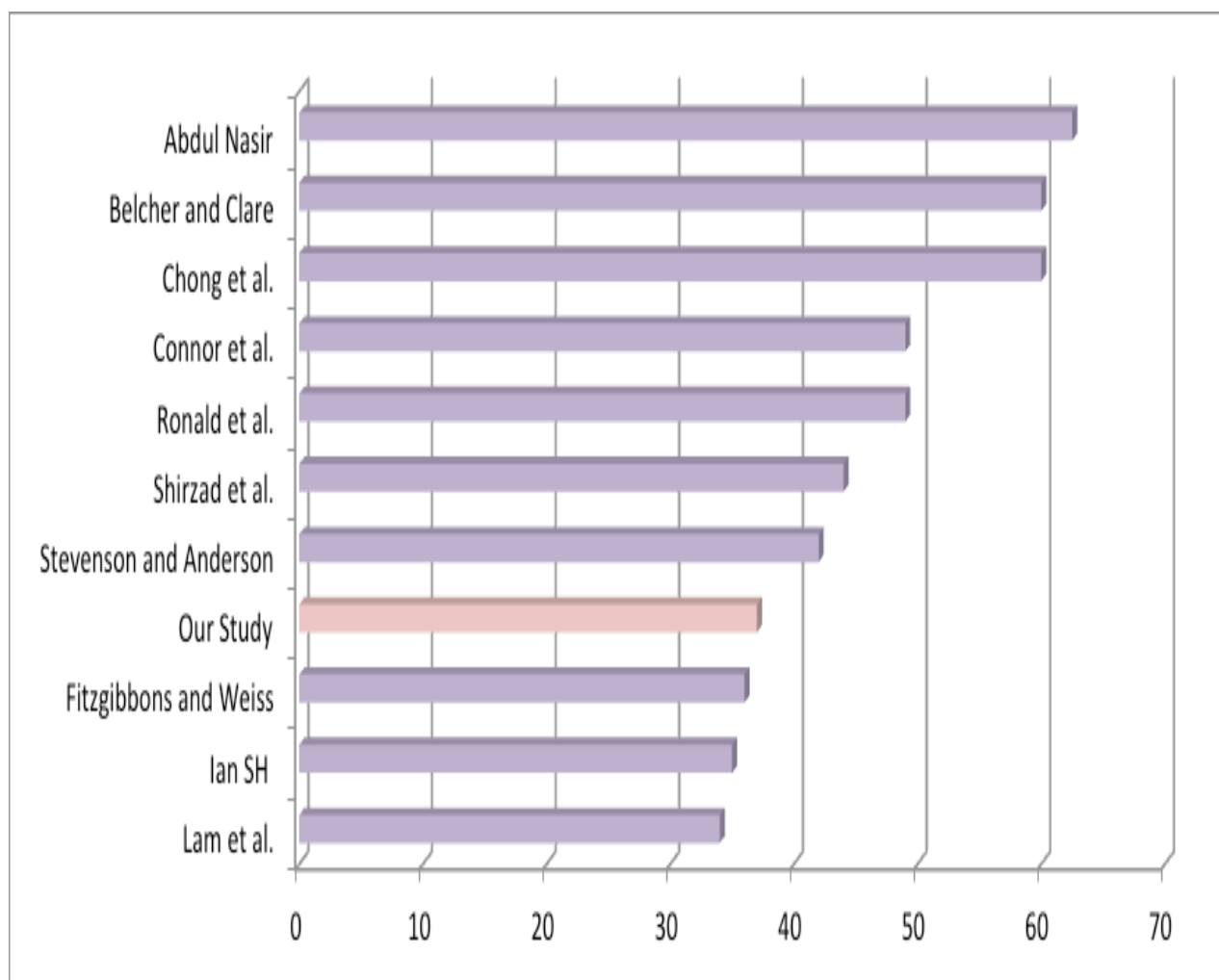


Figure 2. Distribution of Staphylococcus in patients with hand infection. Studies are indicated by first authors. The details are given in the references list

Results

Patients' characteristics

Among 114 patients with diabetic hand from Qassim University, female section, 103 were students (90.4%) and 11 (9.6%) were non students (females workers) and the age ranged from 18 to 54 years. Among 68 control case, 45 were students (66.2%) and 23 (33.8%) were non students. We identified 125 patients between the ages of 18 and 24 years (68.7%) and 57 patients between 25 and 54 (31.3%). There was a preponderance of students (81.3%), because we are at University where the number of students is more important and the age rate of students less than 24 years. All patients lived in Qassim region.

Diabetes and hand infections

History of development of the infection in the hand was also not very long. The left hand was involved in 40 patients

and the right hand in 87 subjects. 55 patients had bilateral hand involvement. The types of infection diagnosed are listed in order of frequency in Figure 1. Majority of the patients were suffering from T1DM. The distribution of the patients according to the type of diabetes was as follows: 109 (95.6%) had T2DM and 5 had T1DM (4.4%). Diabetes was complicated with hypertension in 7 (6.1%) of the cases. Twenty-two patients required only dietary control, 87 needed oral hypoglycemic drugs, and 5 were insulin treated.

Bacterial isolates

We found that the flora from the hand of diabetic patients is rich in Gram-negative rods, while Gram-positive cocci were observed but with a low percentage. The flora from the hand of the control patients (no diabetics) is characterized by the Gram positive cocci in groups or in chains.

The frequency of bacterial isolation from hand cultures obtained during the various culture periods is presented in Table 1. *E. coli* was the most prevalent organism in diabetic patients while *S. aureus* is present in no diabetics with high prevalence. *S. viridans*, *Proteus* and *Candida* was isolated from hand cultures of diabetic's patients, but not from control cases. Anaerobic bacteria were present in 24 patients with diabetes and only 2 from control cases. There was no particular relationship between the different types of hand infection and specific organisms.

Discussion

The hand can easily be injured during everyday activities and any trauma, particularly a penetrating trauma, may introduce damaging pathogens (5). The hand may reveal substantial pathology in diabetes, and ideally, clinical examination should not ignore it (1). Majority of hand infections were observed in young age group followed by middle aged, adolescents and elderly patients (14). In our study, 68.7% of our patients are ranging from 18 years to 24 years old. Lam et al. (12) found that eleven of the 60 patients had diabetes mellitus. We collected 114 among 182 patients that are patients with diabetes. A number of joint disorders affecting the hands exist which have a link with diabetes. Hand infections are common and in the absence of appropriate management, can result in serious and permanent disability (14). Accordingly, people with diabetes are at increased risk for hand infection (15). Diabetic hand ulceration, a rare complication of diabetes, was found in 0.37% (16), hand abscess in 6 cases (12), paronychia in 21.16% (17), in 27.5% (18) and in 35% (14,3). We found 11 cases (9.6%). We found hand ulcer in 9 patients (7.9%) and hand abscess in 2 patients (1.8%).

Bacteria are the most frequent pathogens found in hand infections but viral, fungal or protozoal infections are also well described (5,8). Majority are caused by Gram-positive organisms (19). This is particularly true in patients without diabetes, while in the case of diabetic hand infections Gram-negative organisms and found 52% of patients had mixed infections containing Gram positive, Gram negative and candida (20). Predominance of Gram-negative organisms was reported in hands of patients with diabetes. In our study, the Gram negative bacteria was identified in 62.3%. We found that the organism most preponderant in hand of patients with diabetes is *E. coli* (33.3%) while in control *S. aureus* was identified in 37.7%. In patients with diabetes Gram positive cocci such as *S. aureus* (15.6%), *beta-hemolytic Streptococci* (12.1%), *S. viridans* (7.1%) and

Gram negative bacilli as *Pseudomonas* (10.6%), *Proteus* (7.8%), *Enterobacter* (5.7%) are also founded. *Candida albicans* was present only in this group (2.8%). Anaerobes also was observed in both group. The preponderance of Gram negative bacteria was reported between 31-73% by many workers (12,15,18,22-24). Gram negative bacteria in patients with diabetes was also reported by several groups. These included *E. coli* 0.72-4.2% (19, 25, 26), *Proteus* (*Proteus vulgaris* in 4.2%) (12, 19,25,26), *Pseudomonas aeruginosa* at rates of 1.3-7.2% (12,14,18,26,27), *Klebsiella* at rates of 3.5-7% (9,12,19,25,26,27), *Enterobacter* in 1.9-5.6% (9,12,19,28), and *Aerobacter aerogens* in 0.72% (14). *Klebsiella* was the most common Gram negative organism along with *staphylococcus* species in mixed infection by Jalil et al. (20) and *Klebsiella*, *Enterobacter*, *Proteus* and *E. coli*, constituted approximately 25% of cultured organisms by Belcher et al. (8). Connor et al. (28) reported the presence of Gram-negative organisms in 31% including *Escherichia coli*, *Pseudomonas aeruginosa*, *Proteus vulgaris*, and species of *Klebsiella*, *Serratia*, *Haemophilus*, *Enterobacter*, *Eikenella*, *Pasteurella*, and *Neisseria*. Dorko et al (27) reported the presence *Neisseria* spp. Most authors report the role predominantly of *S. aureus* in hand infection but with different percentage (14,19,22,26,28). Figure 2 shows the frequency of *Staph aureus* in different series (2-4,12-15,21, 22-23, 28,29).

Coagulase negative *Staphylococcus* in 5.7% to 12.6% (8, 9,18). The presence of *Streptococcus* spp was also reported in rates 5.6-16% (19, 28). The beta-haemolytic streptococci were mostly *S. pyogenes* between 3.6 and 12.5% (9,14,18,27). Dorko et al. (27) reported the presence of alpha-hemolytic streptococci with a percentage of 22.4% (18). Non-beta haemolytic streptococci are mostly *S. Viridians* (8) found in 1.3% (18), 2.16% (14). Stevenson et al. (18) reported *S. faecalis* in 0.7%, in 1.7% (9). *Streptococcus agalactiae* was found as the pathogen in one patient with diabetic hand ulcer (23). *Enterococcus* grew in four cases in patients with diabetes among them three were *E. faecalis* (9%) (24), isolated anaerobic organisms in 9%. Stevenson et al. found *Bacteroides* in 5.9% and others anaerobes in 5.3% with hand infections. Also, *Eikenella* in 2.7%, *Prevotella* (1.5%), *Peptostreptococcus* (1.2%) was reported (9,18). Connor et al. (28) found anaerobic organisms in 9% including *Clostridium perfringens*, *Bacteroides* and *Fusobacterium* and *Veillonella*. A fungal etiology should be considered in the differential diagnosis of any hand infection in an immunocompromised person or in any hand infection that fails to respond to conventional treatments

(10). *Candida* organisms were cultured with 10.3% in the study of Jalil et al (20) and this fungi was cited as most frequently associated with chronic paronychia (3,5,17,22). Viral infection is caused by herpes simplex virus (HSV) 1 and 2. HSV-1 infections (12). Best practice management requires use of appropriate diagnostic tools, understanding by the surgeon of the unique and complex anatomy of the hand, and proper antibiotic selection in consultation with infectious disease specialists (30).

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