

## The clinical and microbiological profile of the diabetic hand: A retrospective study from South India

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### ABSTRACT

**Background:** Pyogenic Infections of the hand in diabetes are largely a tropical entity and published material in the area are rather meagre. **Patients and Methods:** This is a retrospective study on the pattern of hand infections and involves the microbiological profile of 39 cases of diabetes hand-related infections admitted to the hospital between the years 2004 and 2010. **Results:** This study included 39 patients, among whom 23 (59%) had necrotizing fasciitis (NF), and 16 (9-abscess and 7-tenosynovitis) had nonnecrotizing infection. Among 25 culture positive patients, polymicrobial infections were isolated in 13 (52%) patients, a single organism was isolated in 9 (36%) and 3 (12%) had sterile cultures. Out of the 41 different bacterial isolates, 51.12% were Gram-negative and 48.78% were Gram-positive. Patients with NF had a higher mean glycated hemoglobin ( $10.83 \pm 2.59$  vs.  $8.64 \pm 1.8\%$ ,  $P = 0.020$ ), when compared to the nonnecrotizing group. Patients with NF also had more polymicrobial infections ( $P = 0.017$ ), and a longer duration of hospitalization when compared to patients without NF ( $21.8 \pm 9.96$  vs.  $12.7 \pm 14.5$  days,  $P = 0.021$ ). Seven (17.94%) patients required amputation of the affected digits of which six (15.38%) had NF. **Conclusion:** Patients with poor glycemic control, polymicrobial infection, delay in presentation, and a prior surgical intervention at another medical center was associated with more severe necrotizing infections. The duration of hospitalization and amputation rates was greater among patients with NF.

**Key words:** Diabetes mellitus, necrotizing fasciitis, polymicrobial infection

### INTRODUCTION

Diabetic hand-related infections or “the diabetic hand” is a less commonly recognized entity when compared to diabetic foot related infections. The diabetes hand-related infections generally constitute <1% of all admissions in patients with diabetes,<sup>[1]</sup> and it is seen almost exclusively in developing countries of the tropical world. The initial reports of diabetic hand infection (DHI) were first reported

by Akintewe *et al.* from Nigeria.<sup>[2,3]</sup> However, this entity has been reported much earlier in the West in the 1970s. McConnell and Neale from USA reported 204 cases of hand infections among which 7% had diabetes mellitus as a risk factor.<sup>[4]</sup> Subsequently, a report of 22 cases of upper extremity infection in patients with diabetes was documented.<sup>[5]</sup> This entity was recognized variably as the tropical diabetes hand syndrome (TDHS), diabetic hand sepsis syndrome, and DHI. However, the term “TDHS” is commonly utilized because it appears to be more common in developing countries of the tropical world.<sup>[6-9]</sup> TDHS is defined as an acute pyogenic infection of the hand, which is characterized by a mild form of infection such as cellulites,

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swelling of the hand, and ulceration that progress into more fulminant infections such as necrotizing fasciitis (NF) and gangrene of the hand and upper limb.<sup>[10,11]</sup> The hand infections in patients with diabetes may at times be very severe and can be associated with an increased risk of mortality due to sepsis and in cases of survival, can cause significant morbidity due to amputation and functional disability.<sup>[12-14]</sup> From 1990 onward, DHI had declined in prevalence in the Western World; however, it continues to be common in African and Asian countries.<sup>[15-18]</sup> However, currently available literature regarding the nature and pattern of DHIs is still limited, owing to the relatively rare presentation of the disorder. The aim of the current study was to determine the pattern of hand infections, the microbiological profile, and the outcome of diabetic hand related infections.

## PATIENTS AND METHODS

This is a retrospective study involving 39 cases of patients with diabetic-related hand infections who presented to the hand surgery department between 2004 and 2010. The hospital electronic medical records were reviewed to obtain the data. A proforma was used to capture the data with regards to the demographic profile, predisposing factors, type of diabetic hand-related infections, surgical procedures in other centers prior to admission, delay in presentation from the onset of symptoms, pattern of surgical procedures and clinical outcomes. Data on the glycemic profile fasting plasma glucose (FPG) and glycated hemoglobin (HbA1c) at the time of admission too were reviewed. Aerobic and anaerobic culture reports on wound swabs and debrided soft tissue specimens were also included in the study. Antibiotic sensitivity patterns of the individual bacterial isolates were studied. The type of diabetes and duration of diabetes was also included in the study.

Diabetes hand infections in this study were classified into three major groups (a) NF, (b) tenosynovitis, and (c) abscesses. Anatomically restrained abscesses in the tenosynovium with classical Kanaval signs were defined as the tenosynovitis pattern.<sup>[19]</sup> All the other abscesses with anatomical constraints and widespread necrosis of the fascia along with or without osteitis were defined as NF. The tenosynovitis and hand abscess group were further classified into a non-necrotizing group for statistical analysis in view of the small sample size.

Early surgical debridement was performed in all cases, based on the clinical condition of the diabetic hand-related infection. After initial debridement, wound management was done by the same surgeon in the ward on a daily basis. Secondary reconstruction procedures such as split thin skin

grafting (STSG) from the thigh or hand itself, a regional flap cover, posterior inter-osseous artery skin flaps (fillet flap cover) or other soft tissue cover procedures were performed when the wound was suitable for grafting. An amputation was considered in the setting of NF or osteitis. Patients who had features of abscess and tenosynovitis alone with superficial tissue involvement were empirically treated with amoxicillin and clavulanate and those with features of NF with involvement of deep tissues such as muscle, fascia and tendon, or suspected osteitis were treated on piperacillin and tazobactam in the initial phase. In patients who were diagnosed to have methicillin resistant *Staphylococcus aureus* (MRSA) infection, therapy with linezolid and rifampicin was given for a period of 3 weeks. Along with wound management, a standard diabetes care management protocol was followed for all patients. A four point glucose profile (fasting, 2 hour post breakfast, lunch, and dinner) were monitored during their inpatient stay. Patients were treated with either insulin or combination insulin and oral antidiabetic agents to achieve adequate glycemic control. Once the wound healed adequately and when self-dressing was possible at home, patients were discharged from the hospital.

Following discharge, the patients were followed up regularly in the endocrine outpatient department (OPD) for glycemic control and in the hand surgery OPD for surgical follow-up and physiotherapy. This study was approved by the Institutional Review Board (IRB No. 8414; dt. 13.08.2015).

### Statistical analysis

Statistical analysis was performed using the SPSS software package (version 17, IBM Corp. in Armonk, NY). In this study the DHI were further classified into Group 1: Patients with NF-23 and Group 2: Nonnecrotizing fasciitis (NNF)-16 which included patients with both abscess-9 and tenosynovitis-7 for statistical analysis. The Mann-Whitney U-test and Chi-square test were used to determine the relationship between the clinical characteristics of NF patients. Multivariate analysis was performed using logistic regression to determine the correlation between various clinical characteristics with a prolonged duration of hospitalization.

## RESULTS

### Patients characteristics

A total of 39 patients with Type 2 diabetes mellitus were included in this study among whom 24 (61.5%) were males and 15 (38.46%) were females. The mean age was  $50.89 \pm 10.61$  years (33–73 years). The mean duration of diabetes was  $(7.01 \pm 4.54)$  years (0–16). The mean HbA1c value was  $10.07 \pm 2.54\%$  (7.1–15.7%). The mean FPG level was  $313.64 \pm 86.377$  mg/dl (113–515 mg/dl).

The DHI in this study was categorized into three groups: (1) Necrotizing fasciitis (2) abscess and (3) tenosynovitis. No patient presented at the stage of cellulitis. Twenty three (58.97%) patients presented with necrotizing fasciitis (NF), 9 (23.07%) had abscess, and 7 (17.94%) had tenosynovitis. The patients with abscesses and tenosynovitis groups were further categorized into nonnecrotizing group (NNF). The Images on the various types of hand infection were shown in Figures 1, 2 and 3a and b. In many patients either with abscesses or tenosynovitis and NF, the infection was found to be continuous. The mean delay in presentation to hospital was  $6.0 \pm 2.5$  (3–16) days. A total of 8 (20.5%) had a history of prior surgical intervention in other centers prior to admission to our hospital. The mean duration of hospitalization was  $14 \pm 12.736$  (3–64) days.

### Predisposing factors

Eleven (28%) patients had a history of antecedent trauma; however, no definite predisposing factors were identified

in 28 (72%). The details of predisposing factors for hand infections are shown in Figure 4. In subjects with a prior history of antecedent trauma, 9 (82%) had NF and 2 (18%) subjects hand abscesses, while in subjects without any predisposing factors, NF was seen in 14 (50%) of cases. Three patients had a thorn prick injury and all had NF.

### Bacteriology

Out of 39 patients, comprehensive bacteriological data was available in only 25 patients among whom, polymicrobial infections were detected in 13 (52%), 9 (36%) had monomicrobial infection and 3 (12%) had a sterile culture. A total of 41 different bacteria among 13 different bacterial species were detected. Among the 41 bacterial isolates, Gram-positive bacteria constituted about 48.78%, and Gram-negative bacteria constituted about 51.21% of isolates. Among the Gram-negative isolates, *Klebsiella* and *Pseudomonas aeruginosa* species were found to be more common. Among Gram-positive isolates, *Staphylococcus* infections was more common (Details of the



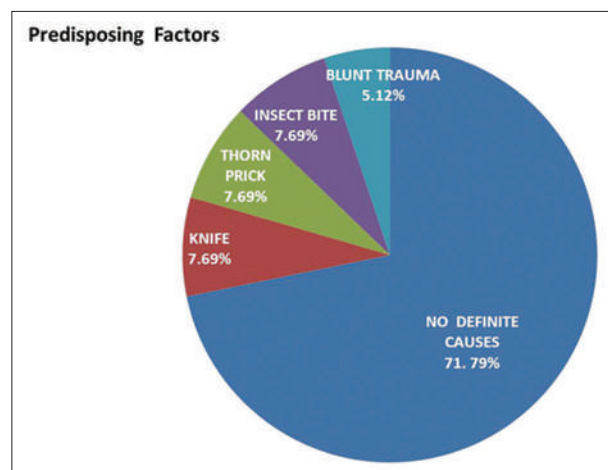
**Figure 1:** Necrotizing fasciitis in a 54-year-old man following a thorn prick injury and subsequent surgical intervention outside



**Figure 2:** Features suggestive of flexor tenosynovitis of left middle finger in a 41-year-old lady who presented with spontaneous onset pain, redness and swelling



**Figure 3:** (a and b) Flexor pollicis longus tenosynovitis which evolved into necrotizing fasciitis in a 45 years male with poor glycemic control



**Figure 4:** Predisposing factors in diabetic hand infections

microorganisms grown in culture of the patients with DHI have been shown in Table 1).

### Surgical procedures and healing pattern

Twelve (31%) patients had exclusive debridement as a surgical procedure and the wounds healed spontaneously without any reconstructive procedure for skin cover or bony stability. Ablation of the affected digits were needed in 7 (18%) of cases, of which 6 had NF. A total of 15 (38%) patients needed skin and soft tissue reconstructive procedures, among whom three patients (7%) had a regional flap cover (cross finger in two patients and a posterior interosseous arterial flap in 1 patient), 12 (31%) patients had STSG from the thigh or hand itself. Out of the seven patients with digital amputations, three patients required a fillet flap from the amputated digits for skin cover and two patients required a bony procedure to stabilize the digits.

### Necrotizing fasciitis and nonnecrotizing diabetic hand infection

A total of 23 patients had NF and 16 had non necrotizing DHI (NNF). Among patients with NF, 17 (73.91%) were male and six (26.08%) are female. The clinical characteristics of the study subjects (necrotizing fasciitis and NNF) are shown in Table 2. Patients with NF fasciitis had a higher mean FPG level and higher mean HbA1c level when compared the patients with NNF. Patients with NF had more polymicrobial infections when compared to the NNF group (85.7% vs. 14.3) with a  $P = 0.017$ . Seven out of eight (87.5%) patients with a prior surgical intervention at other centers prior to being admitted in our hospital had NF; however, it was also found to be not significant with regard to the evolution of

NF ( $P = 0.109$ ). The mean delay in presentation to hospital since the initial onset of symptoms in NF patients was  $6.35 \pm 2.9$  days versus  $5.5 \pm 1.83$  days in the NNF patients group ( $P = 0.454$ ). The mean duration of hospitalization in patients with NF group was longer ( $21.8 \pm 9.96$  days) when compared to the NNF group ( $12.7 \pm 14.5$  days) and which was found to be statistically significant ( $P = 0.001$ ).

## DISCUSSION

The current study was designed to focus on the types of hand infection, pattern of microbiological profile in patients with DHIs. There were 23 patients (54%) presenting with necrotizing fasciitis; 9 (26%) with abscesses, and 7 (20%) had tenosynovitis. Among patients with abscesses, three had thumb abscess (two had felon abscess), one had a middle finger abscess, one had a first web space abscess, two had thenar, and two had mid-palmar abscess. Patients in

**Table 2: Clinical characteristics of the study subjects with necrotizing fasciitis and nonnecrotizing fasciitis**

| Characteristics                        | Necrotizing fasciitis group (n=23) | Nonnecrotizing fasciitis group (n=16) | P     |
|----------------------------------------|------------------------------------|---------------------------------------|-------|
| Sex, n (%)                             |                                    |                                       |       |
| Male                                   | 17 (70.8)                          | 7 (29.2)                              | 0.94  |
| Female                                 | 6 (47)                             | 9 (53)                                |       |
| Presence of predisposing factors, n(%) |                                    |                                       |       |
| Yes                                    | 9 (81.82)                          | 2(18.18)                              | 0.169 |
| No                                     | 14(50%)                            | 14(50%)                               |       |
| Previous surgery, n (%)                |                                    |                                       |       |
| Yes                                    | 7(87.5)                            | 1(12.5%)                              | 0.109 |
| No                                     | 16(51.6%)                          | 15(48.4%)                             |       |
| MRSA, n (%)                            |                                    |                                       |       |
| Yes                                    | 3 (60.0)                           | 2 (40.0)                              | 1.000 |
| No                                     | 20 (58.8)                          | 14 (41.2)                             |       |
| Polymicrobial infection, n (%)         |                                    |                                       |       |
| Yes                                    | 11 (85.7)                          | 2 (14.3)                              | 0.017 |
| No                                     | 12 (44.0)                          | 14 (56.0)                             |       |
| Single microbial, n (%)                |                                    |                                       |       |
| Yes                                    | 2 (22.2)                           | 7 (77.8)                              | 0.019 |
| No                                     | 21 (70.0)                          | 9 (30.0)                              |       |

**Table 1: Pattern of microorganisms isolates in patients with diabetic hand infections**

| Microorganisms isolates                     | All 41 bacterial isolates n(%) | Single organism 9/out of total 41 bacterial isolates |
|---------------------------------------------|--------------------------------|------------------------------------------------------|
| Gram negative bacilli: n=21 (51.22%)        |                                |                                                      |
| <i>Klebsiella</i>                           | 8 (19.51)                      | 2                                                    |
| <i>Pseudomonas aeruginosa</i>               | 3 (7.37)                       | 1                                                    |
| <i>Escherichia coli</i>                     | 3 (7.37)                       | 0                                                    |
| <i>Aeromonas</i>                            | 1 (2.43)                       | 0                                                    |
| <i>Enterobacter</i> spp.                    | 4 (9.75)                       | 0                                                    |
| <i>Citrobacter diversus</i>                 | 1 (2.43)                       | 1                                                    |
| Nonformative GNB                            | 1 (2.43)                       | 0                                                    |
| Gram-positive cocci isolated: n=20 (48.78%) |                                |                                                      |
| <i>Staphylococcus aureus</i> (MSSA)         | 5 (12.19)                      | 3                                                    |
| MRSA                                        | 5 (12.19)                      | 1                                                    |
| CoNS                                        | 3 (7.37)                       | 0                                                    |
| Group-B <i>Streptococcus</i>                | 3 (7.37)                       | 0                                                    |
| Group-C <i>Streptococcus</i>                | 3 (7.37)                       | 0                                                    |
| Group-D <i>Streptococcus-Enterococcus</i>   | 1 (2.43)                       | 1                                                    |

GNB: Gram-negative bacilli, MSSA: Methicillin sensitive *Staphylococcus aureus*, MRSA: Methicillin resistant *Staphylococcus aureus*, CoNS: Coagulase-negative staphylococci

| Parameters                                     | Mean±SD                            |                                        | P     |
|------------------------------------------------|------------------------------------|----------------------------------------|-------|
|                                                | Necrotizing fasciitis group (n=23) | Non necrotizing fasciitis group (n=16) |       |
| Age (years)                                    | 51.48±9.12                         | 50.06±12.74                            | 0.688 |
| Duration of diabetes (years)                   | 7.15±4.65                          | 7.25±5.02                              | 0.144 |
| HbA1c %                                        | 10.83±2.59                         | 8.64±1.8                               | 0.021 |
| Fasting plasma glucose at admission in (mg/dl) | 324.22 ± 94.8                      | 298.4±72.7                             | 0.275 |
| Delayed in presentation (days)                 | 6.35±2.9                           | 5.5±1.83                               | 0.454 |
| Duration of hospitalization (days)             | 21.8±9.96                          | 12.7±14.5                              | 0.001 |

MRSA: Methicillin resistant *Staphylococcus Aureus*, HbA1c: Glycated hemoglobin, SD: Standard deviation

this series, differed from other series as none of the patients presented with superficial cellulitis or with fulminant sepsis. In the series by Pinzur *et al.*, 82% of patients presented with cellulites.<sup>[20]</sup> Two studies, one from Nigeria and other from Libya had a fulminant sepsis rate of 3% in patients with DHIs.<sup>[3,7]</sup> In our study, antecedent trauma was a predisposing factor in 28% of patients; however, in 72% of cases, there was no obvious cause. The predisposing factors for a diabetes hand-related infections varied according to the population studied; however antecedent trivial trauma, constituted about 16–36% of cases in previous studies.<sup>[6,21]</sup> In our study, diabetic hand-related infections were more common among men (61.5%). Similar reports of predominantly male patients with DHIs have been reported.<sup>[10,14]</sup> Irrespective of the gender, the risk for development of DHIs was dependent upon the nature of the occupation. Archibald *et al.* and McLigeyo *et al.* had shown that DHIs were more common in females due to trauma sustained during household work, such as a knife injury.<sup>[9,22]</sup> In our study, the mean age group for diabetic hand-related infections was 50.89 years (mean  $\pm$  standard deviation:  $50.89 \pm 10.6$ ). However, the range in terms of age of patients with DHIs may vary from 17 to 80 years in different series.<sup>[1,10]</sup>

In our study, out of 39 patients, 22 had shown positive microbial cultures, 13 (52%) had polymicrobial infection and a single organism was isolated in 9 (36%) patients. In polymicrobial infections, *Klebsiella* and *Staphylococcal* infections were found to be more common. Similarly, a study by Jalil *et al.* reported that 52% of patients in their series were found to have polymicrobial infections and *S. aureus* and *Klebsiella* were more common.<sup>[17]</sup> Previous studies by Gonzalez *et al.* showed that 46% of had polymicrobial infections and 55% by Kour *et al.*<sup>[14,21]</sup> In our study, Gram-negative organisms were isolated in 51.21% and Gram-positive organisms in (48.78%). Similarly, Kour *et al.* reported that 73% of culture positive infections were due to Gram-negative organisms.<sup>[14]</sup>

Among Gram-positive organisms, *Staphylococcus* constituted about 31.7% of all culture positive isolates. Totally, 13 (52%) had grown *S. aureus* and MRSA was detected in 5 (20%) patients. Out of 9 patients with monomicrobial infections, 4 patients had grown staphylococcus among which one had MRSA. Bach *et al.* reported that 73% of hand infections in an urban setting were related to MRSA.<sup>[23]</sup> In a community-based study on hand infections by Wilson and Rinker, the overall prevalence of MRSA infection was 64% and was 20% among diabetic subjects which was comparable to our study.<sup>[24]</sup> Isolated Gram-negative infections were seen in four patients of whom 2 had *Klebsiella*, one had *Pseudomonas* and one had *Citrobacter*

infection. Isolated Gram-negative infections were reported in 11% by Jalil *et al.*, and *Citrobacter* infections were also seen in their study.<sup>[17]</sup>

In our study, 31% ( $n = 12$ ) required only surgical debridement, following which the ulcer healed spontaneously without any reconstructive procedure for skin cover or bony stability. Seven (18%) of our study population required amputation of the digits to control infection, or due to gangrene of the digits. Among the group with amputation, six had NF and one had a nonviable index finger due to trauma.

A study by Gonzalez *et al.* showed that the amputation rate was as high as 39%. The increased rate of amputation in their study was related to deep tissue infection, renal failure and infection due to Gram-negative and polymicrobial infections.<sup>[21]</sup> In Francel's series, the amputation rate was found to be 100% in patients with diabetes with underlying renal transplantation.<sup>[13]</sup> Similarly, Mann and Peacock reported a 35% amputation rate, and Jalil *et al.* reported a 16.2% amputation rate.<sup>[5,17]</sup> A low amputation rate in Jalil *et al.* series was attributed to multiple debridement and an aggressive approach towards the management of the diabetic hand.<sup>[17]</sup>

A reconstruction procedure was performed in 18 patients with DHI patients when wound had healed that was enough for grafting. In this study, 15 (38%) patients needed skin and soft tissue reconstructive procedures. Angoules *et al.* reported that nearly half of the patients with NF required reconstructive procedures (skin and soft tissue flap). In our study, 3 (7%) patients required regional flap cover and 12 (31%) required STSG. Two patients required bony procedures to stabilize the digits.

Appropriate empirical intravenous antibiotics were administered soon after hospitalization without any delay. Surgical debridement was performed within a period of 4–5 hours after hospitalization.

The mean duration of hospitalization was  $\pm 12.736$  (3–64) days. The duration of hospitalization was  $21.8 \pm 9.96$  days in the group with NF, while it was  $12.7 \pm 14.5$  days in the with nonnecrotizing group (the duration of hospitalization was  $13.4 \pm 8.3$  days in the group with abscesses group and  $12.63 \pm 7.3$  days in the group with tenosynovitis, respectively). The important factors responsible for a lengthy duration of hospitalization were delay in presentation to hospital, poor glycemic control (a higher HbA1c level), high random plasma glucose levels at admission, MRSA infections, and a prior surgical procedure in a previous institution. However, none of the parameters were found to be statistically significant, probably due to the small

sample size. A study by Jalil *et al.*, the longer duration of hospitalization was associated with polymicrobial infections. In our study, polymicrobial infections were not found to be associated with an increased duration of hospitalization.<sup>[17]</sup> A retrospective study by Gonzalez *et al.* showed that a longer duration of hospitalization was related to the severity of infections (deep tissue infection) and polymicrobial infections.<sup>[21]</sup>

### Limitations of the study

The occupation of the patients were not evaluated, the microbiological culture reports were not available for all the patients and follow-up and long-term outcome of the patients who had undergone surgical procedures were not studied in view of the retrospective nature of the study. The status of peripheral neuropathy and peripheral vascular disease was not specifically addressed in this study.

## CONCLUSION

Diabetes hand infections are one of the less common complications of diabetes and are frequently associated with NF and gangrene. Unrecognized trivial trauma remains the most common predisposing factor. A delay in presentation and poor glycemic control are important causes for the severity of hand infections. Early surgical intervention, good glycemic control, and early initiation of broad spectrum antibiotics are essential for the rapid healing of hand infections. This study highlights the need for increased awareness among physicians regarding diabetic hand-related infections, so that an early referral may be possible to prevent overt complications.

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### Conflicts of interest

There are no conflicts of interest.

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