



## CLINICOPATHOLOGICAL AND MICROBIOLOGICAL CORRELATION OF DIABETIC FOOT INFECTIONS IN PATIENTS UNDERGOING SURGICAL MANAGEMENT

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### Abstract

Diabetic foot infection (DFI) is a major complication of diabetes mellitus and an important cause of hospitalization, surgical intervention, and lower-extremity amputation. Clinicopathological assessment combined with microbiological evaluation may facilitate appropriate antimicrobial therapy and surgical decision-making.

### Methods

This prospective observational study included 100 patients with diabetic foot infections undergoing surgical management. Clinical characteristics, Wagner grade, glycaemic status, peripheral neuropathy, peripheral arterial disease, and surgical procedures were recorded. Deep-tissue specimens obtained during surgery were subjected to microbiological culture, antimicrobial susceptibility testing, and histopathological examination. Clinical, microbiological, and pathological findings were correlated with disease severity and surgical outcomes.

### Results

The mean age was  $56.8 \pm 10.9$  years, and 72.0% were males. Wagner Grade  $\geq 3$  disease was present in 67.0% of patients. Microbiological cultures were positive in 91.0%, with 38.5% being polymicrobial. Gram-negative organisms constituted 63.6% of isolates. *Staphylococcus aureus* was the most frequent individual isolate (25.0%), followed by *Escherichia coli* (18.2%) and *Pseudomonas aeruginosa* (15.9%). Multidrug resistance was detected in 36.4% of isolates. Histopathological examination demonstrated tissue necrosis in 52.0% and osteomyelitis in 27.0%. Overall, 43.0% underwent amputation. Amputation was significantly associated with Wagner Grade  $\geq 3$ , multidrug-resistant infection, peripheral arterial disease, tissue necrosis, and osteomyelitis.

### Conclusion

Advanced clinical severity, antimicrobial resistance, vascular compromise, tissue necrosis, and osteomyelitis were important correlates of adverse surgical outcomes in DFI. Integrated clinicopathological and microbiological assessment may facilitate targeted antimicrobial therapy, timely surgical intervention, and limb preservation.

### Keywords

Diabetes mellitus; diabetic foot infection; diabetic foot ulcer; microbiological profile; antimicrobial resistance; osteomyelitis; amputation; surgical management.

## INTRODUCTION

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by persistent hyperglycaemia resulting from abnormalities in insulin secretion, insulin action, or both. It is a major global public health problem and contributes substantially to morbidity, mortality, disability, and healthcare expenditure. With the increasing prevalence and duration of diabetes, the burden of its chronic complications is also rising. Among these, diabetic foot disease is one of the most serious complications because of its association with recurrent hospitalization, prolonged treatment, impaired quality of life, lower-extremity amputation, and mortality.[1] Diabetic foot ulcers (DFUs) develop due to the interaction of several factors, including peripheral neuropathy, peripheral arterial disease, repetitive trauma, foot deformity, poor glycaemic control, and impaired host defence mechanisms. Loss of protective sensation predisposes patients to unnoticed trauma and abnormal pressure, while vascular insufficiency reduces tissue perfusion and delays wound healing.[2] Persistent hyperglycaemia and impaired immune responses further increase susceptibility to infection. Diabetic foot infection (DFI) develops when microorganisms invade the tissues of an ulcer and produce an inflammatory response.[3] Infection may remain limited to superficial tissues or extend to deeper structures, resulting in cellulitis, abscess formation, tissue necrosis, gangrene, tendon or fascial involvement, septic arthritis, and osteomyelitis.[4] Severe infections may lead to sepsis and limb loss. Therefore, early assessment of the severity and extent of infection is essential for appropriate treatment and limb preservation. Clinical evaluation includes assessment of ulcer size, duration, depth, discharge, surrounding inflammation, necrosis, gangrene, vascular status, neuropathy, and possible bone involvement.[5] Classification systems such as the Wagner grading system are commonly used to determine disease severity and guide management. However, clinical appearance may not always accurately reflect the underlying depth of infection or tissue destruction.[6] Histopathological examination of surgically obtained tissue can provide important information regarding ulceration, acute and chronic inflammation, granulation tissue, necrosis, vascular changes, abscess formation, and osteomyelitis.[7] Such findings may help determine the actual extent of disease and complement clinical assessment.

Microbiological evaluation is equally important because diabetic foot infections may be monomicrobial or polymicrobial.[8,9] Mild acute infections are commonly associated with Gram-positive cocci, particularly *Staphylococcus aureus* and streptococci, whereas chronic, deep, recurrent, or previously treated infections may also contain Gram-negative bacilli and anaerobic organisms.[10] The emergence of multidrug-resistant organisms, including MRSA, ESBL-producing Gram-negative bacteria, and carbapenem-resistant strains, further complicates treatment. Deep-tissue or bone specimens obtained during surgery are generally more reliable than superficial swabs for identifying clinically relevant pathogens.[11] Surgical management is essential in patients with abscesses, necrotic tissue, gangrene, deep infection, or osteomyelitis. Procedures may range from incision and drainage and debridement to minor or major amputation. The extent of surgery depends on infection severity, tissue destruction, vascular status, bone involvement, metabolic control, and response to therapy.[12] Therefore, correlation of clinical findings, histopathological changes, microbiological profile, antimicrobial susceptibility, and surgical requirements may provide a more comprehensive assessment of diabetic foot infection. The present study, entitled Clinicopathological and Microbiological Correlation of Diabetic Foot Infections in Patients Undergoing Surgical Management, aims to evaluate these parameters and their relationship with disease severity and surgical outcomes. The findings may assist in early identification of severe infection, rational antimicrobial selection, timely surgical decision-making, and improvement of limb-salvage strategies.

## MATERIALS AND METHODS

This hospital-based, prospective observational study was conducted in the Department of General

## Study Population

The study included adult patients with diabetes mellitus who presented with clinically diagnosed diabetic foot infection and underwent surgical intervention. A total of 100 patients fulfilling the predefined eligibility criteria were enrolled in the study.

## Inclusion Criteria

Patients aged 18 years or above with a confirmed diagnosis of diabetes mellitus, presenting with diabetic foot ulcer with clinical evidence of infection and requiring surgical management, were included. Only patients who provided written informed consent for participation and collection of tissue specimens for microbiological and histopathological examination were enrolled.

## Exclusion Criteria

Patients with non-diabetic foot ulcers, ulcers resulting primarily from trauma, burns, malignancy, or other non-diabetic causes were excluded. Patients who did not require surgical intervention, those from whom adequate tissue specimens could not be obtained, and those who declined to provide informed consent were also excluded.

## Clinical Assessment

A detailed history was obtained from each patient regarding age, sex, duration and type of diabetes mellitus, duration of foot ulcer, previous episodes of ulceration, history of trauma, previous hospitalization, prior antibiotic exposure, smoking, and associated comorbidities. Details regarding antidiabetic treatment and previous treatment received for the foot ulcer were also recorded. All patients underwent a detailed local examination of the affected foot. The site, size, number, duration, depth, and characteristics of the ulcer were documented. The presence of purulent discharge, surrounding erythema, swelling, local warmth, tenderness, necrotic tissue, slough, gangrene, exposed tendon or bone, and clinical evidence of deep infection was recorded. Peripheral neuropathy and peripheral vascular status were assessed clinically. The presence of dorsalis pedis and posterior tibial arterial pulsations was documented. Relevant vascular investigations were performed whenever clinically indicated.

## Classification of Diabetic Foot Ulcers

The severity of diabetic foot ulceration was assessed using the Wagner classification system. Ulcers were categorized from Grade 0 to Grade 5 according to the depth of the ulcer, presence of deep-tissue involvement, osteomyelitis, and extent of gangrene. The Wagner grade at presentation was recorded and correlated with microbiological, histopathological, and surgical findings.

## Laboratory and Radiological Evaluation

Routine laboratory investigations included complete blood count, fasting and/or random blood glucose, glycated haemoglobin (HbA1c), renal function tests, serum electrolytes, and other relevant biochemical investigations. Inflammatory markers, including C-reactive protein and erythrocyte sedimentation rate, were obtained wherever clinically indicated.

Plain radiography of the affected foot was performed when deep infection or osteomyelitis was suspected. Additional imaging investigations were undertaken when required according to the clinical condition of the patient.

## Surgical Management

The decision regarding surgical intervention was based on the clinical severity and extent of

Clinicopathological and microbiological correlation of diabetic foot infections in patients undergoing surgical infection, presence of abscess, necrotic tissue, gangrene, deep-space infection, or suspected osteomyelitis. Surgical procedures included incision and drainage, wound debridement, repeated debridement, excision of infected or necrotic tissue, minor amputation, and major lower-extremity amputation, as clinically indicated.

The type and extent of surgical procedure performed in each patient were recorded. Intraoperative findings, including the presence of pus, tissue necrosis, fascial involvement, tendon involvement, gangrene, and bone involvement, were documented.

#### Specimen Collection

Deep-tissue specimens were obtained under aseptic precautions during surgical intervention. After appropriate cleansing and removal of superficial contaminants and devitalized material, representative tissue samples were collected from the depth or advancing margin of the infected wound.

Where osteomyelitis was suspected and bone was exposed or surgically removed, representative bone specimens were collected whenever feasible. Specimens were appropriately labelled and transported without unnecessary delay to the microbiology and pathology laboratories.

Separate representative specimens were submitted for microbiological culture and antimicrobial susceptibility testing and histopathological examination.

#### Microbiological Examination

The specimens received in the microbiology laboratory were processed according to standard microbiological procedures. Direct microscopy and Gram staining were performed wherever appropriate. Samples were inoculated onto suitable culture media and incubated under appropriate conditions.

Bacterial isolates were identified using standard microbiological methods based on colony morphology, Gram-staining characteristics, biochemical reactions, and/or automated identification systems available in the laboratory.

The infections were categorized as monomicrobial or polymicrobial according to the number of clinically significant organisms isolated. The distribution of Gram-positive and Gram-negative organisms was documented.

#### Antimicrobial Susceptibility Testing

Antimicrobial susceptibility testing of clinically significant bacterial isolates was performed using the Kirby–Bauer disk diffusion method and/or an automated antimicrobial susceptibility testing system, according to the laboratory protocol. Results were interpreted according to the applicable Clinical and Laboratory Standards Institute (CLSI) criteria.

Isolates showing resistance to multiple classes of antimicrobial agents were identified as multidrug-resistant organisms according to standard definitions. The presence of methicillin-resistant *Staphylococcus aureus* (MRSA), extended-spectrum  $\beta$ -lactamase (ESBL)-producing organisms, carbapenem-resistant organisms, and other clinically relevant resistance patterns was documented.

#### Histopathological Examination

Representative tissue specimens obtained during surgical intervention were fixed in 10% neutral buffered formalin and transported to the pathology laboratory. The specimens were processed routinely, embedded in paraffin, sectioned, and stained with haematoxylin and eosin (H&E).

Histopathological examination was performed to assess ulceration, acute and chronic inflammatory

Clinicopathological and microbiological correlation of diabetic foot infections in patients undergoing surgical infiltrates, granulation tissue formation, suppurative inflammation, abscess formation, tissue necrosis, vascular changes, and involvement of deeper soft tissues. In specimens containing bone, histological evidence of osteomyelitis was specifically evaluated.

### Clinicopathological and Microbiological Correlation

Clinical characteristics and severity of diabetic foot infection were correlated with the microbiological and histopathological findings. The Wagner grade, ulcer depth, presence of necrosis or gangrene, osteomyelitis, glycaemic status, and extent of tissue involvement were compared with the type and number of microorganisms isolated and their antimicrobial susceptibility patterns.

Histopathological findings were correlated with microbiological culture results to assess the relationship between tissue inflammation or necrosis and the presence of clinically significant organisms. Clinical, microbiological, and pathological findings were further correlated with the type and extent of surgical intervention.

### Outcome Measures

The primary outcomes evaluated were the microbiological profile of diabetic foot infections, antimicrobial susceptibility patterns, and their correlation with clinical severity and histopathological findings.

Secondary outcomes included the type of surgical intervention required, need for repeated debridement, presence of osteomyelitis, minor or major amputation, duration of hospital stay, and wound outcome during the available follow-up period.

### Statistical Analysis

Data were entered into a computerized database and analysed using [SPSS version 11 statistical software]. Continuous variables were expressed as mean  $\pm$  standard deviation (SD) or median with interquartile range (IQR) according to their distribution, whereas categorical variables were presented as frequencies and percentages.

Associations between categorical variables, including Wagner grade, microbiological profile, histopathological findings, antimicrobial resistance, and surgical outcome, were assessed using the Chi-square test or Fisher's exact test, as appropriate. Continuous variables between groups were compared using the independent-samples t-test or Mann–Whitney U test, depending on data distribution. For comparisons involving more than two groups, one-way analysis of variance (ANOVA) or the Kruskal–Wallis test was used as appropriate.

Multivariable logistic regression analysis was performed, where appropriate, to identify independent factors associated with adverse surgical outcomes, particularly amputation. Results were expressed as odds ratios (ORs) with 95% confidence intervals (CIs). A two-sided p-value  $<0.05$  was considered statistically significant.

## RESULTS

A total of 100 patients with diabetic foot infection who underwent surgical management were included in the study. The clinical characteristics, severity of diabetic foot disease, microbiological profile, histopathological findings, antimicrobial resistance patterns, and surgical outcomes were analysed. Clinicopathological and microbiological findings were further correlated with the severity of disease and the extent of surgical intervention.

### Demographic and Clinical Characteristics

The mean age of the study population was  $56.8 \pm 10.9$  years, with the majority of patients (34.0%) belonging to the 51–60-year age group. There was a male predominance, with 72 (72.0%) males and 28 (28.0%) females. The mean duration of diabetes was  $10.6 \pm 6.2$  years, while 61.0% of patients had diabetes for more than 5 years.

Poor glycaemic control was frequently observed, with a mean HbA1c of  $9.1 \pm 2.0\%$  and 68.0% of patients having HbA1c  $\geq 8\%$ . Peripheral neuropathy was present in 69.0%, while peripheral arterial disease was identified in 34.0%. Hypertension was the most frequent associated comorbidity (48.0%), followed by chronic kidney disease (18.0%). A history of previous antibiotic exposure was documented in 57.0% of patients (Table 1, Figure 1).

Table 1. Demographic and clinical characteristics of study participants (n=100)

| Characteristic               | n (%) / Mean $\pm$ SD |
|------------------------------|-----------------------|
| Age, years                   | $56.8 \pm 10.9$       |
| $\leq 40$ years              | 8 (8.0)               |
| 41–50 years                  | 22 (22.0)             |
| 51–60 years                  | 34 (34.0)             |
| 61–70 years                  | 25 (25.0)             |
| $>70$ years                  | 11 (11.0)             |
| Male                         | 72 (72.0)             |
| Female                       | 28 (28.0)             |
| Duration of diabetes, years  | $10.6 \pm 6.2$        |
| Diabetes duration $>5$ years | 61 (61.0)             |
| HbA1c, %                     | $9.1 \pm 2.0$         |
| HbA1c $\geq 8\%$             | 68 (68.0)             |
| Peripheral neuropathy        | 69 (69.0)             |
| Peripheral arterial disease  | 34 (34.0)             |
| Hypertension                 | 48 (48.0)             |
| Chronic kidney disease       | 18 (18.0)             |
| Previous antibiotic exposure | 57 (57.0)             |

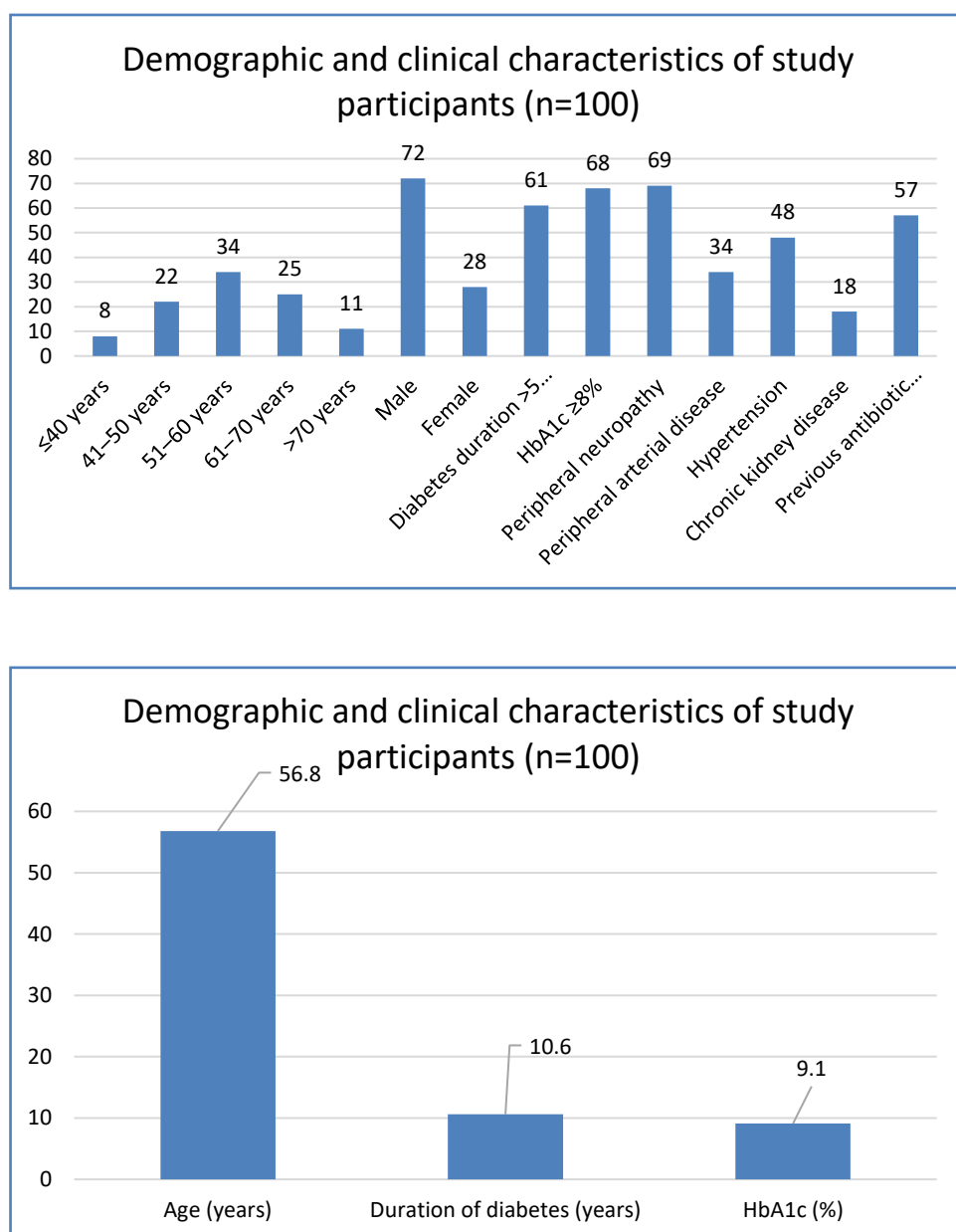


Figure 1 Demographic and clinical characteristics of study participants (n=100)

The forefoot was the most frequently involved anatomical site, accounting for 52.0% of ulcers, followed by the midfoot (27.0%) and hindfoot (21.0%). Purulent discharge was observed in 76.0% of patients, surrounding cellulitis in 64.0%, tissue necrosis in 53.0%, and gangrene in 37.0%. Clinically suspected or radiologically evident osteomyelitis was present in 29.0% of patients.

According to the Wagner classification, Grade 3 disease was the most frequent, observed in 35.0% of patients, followed by Grade 2 in 27.0%, Grade 4 in 24.0%, and Grade 5 in 8.0%. Overall, 67.0% of patients had Wagner Grade  $\geq 3$  disease, indicating a substantial burden of advanced diabetic foot infection in the study population (Table 2, Figure 2).

Table 2. Clinical characteristics and Wagner grading of diabetic foot infection (n=100)

| Clinical characteristic | n (%)     |
|-------------------------|-----------|
| Forefoot involvement    | 52 (52.0) |
| Midfoot involvement     | 27 (27.0) |
| Hindfoot involvement    | 21 (21.0) |
| Purulent discharge      | 76 (76.0) |
| Surrounding cellulitis  | 64 (64.0) |
| Tissue necrosis         | 53 (53.0) |
| Gangrene                | 37 (37.0) |
| Osteomyelitis           | 29 (29.0) |
| Wagner grade            |           |
| Grade 1                 | 6 (6.0)   |
| Grade 2                 | 27 (27.0) |
| Grade 3                 | 35 (35.0) |
| Grade 4                 | 24 (24.0) |
| Grade 5                 | 8 (8.0)   |

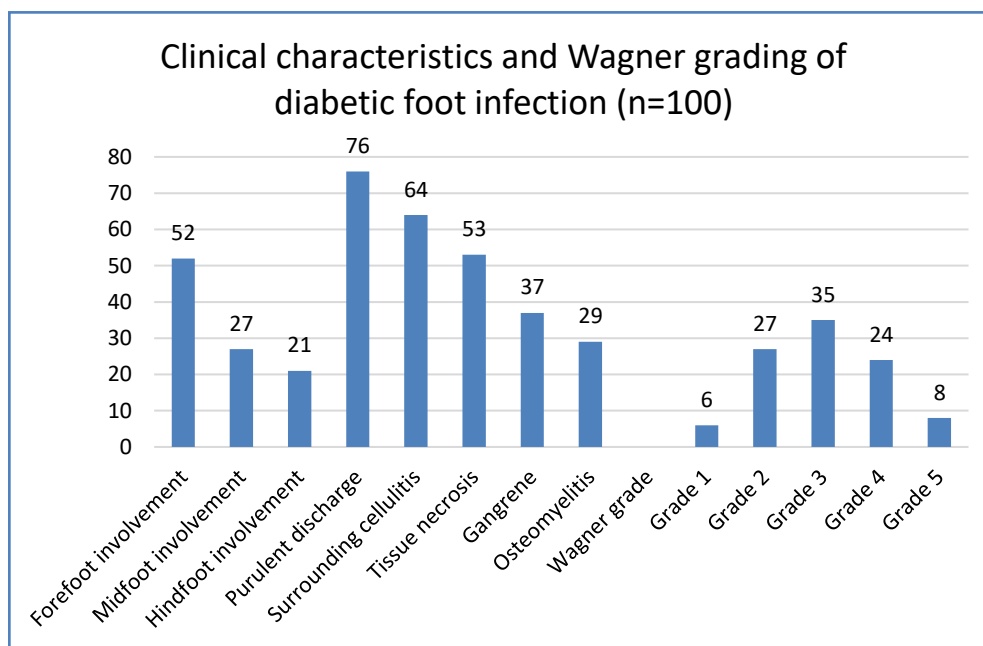


Figure 2 Clinical characteristics and Wagner grading of diabetic foot infection (n=100)



Microbiological culture yielded clinically significant bacterial growth in 91 (91.0%) patients, whereas 9 (9.0%) specimens showed no significant growth. Among culture-positive infections, 56 (61.5%) were monomicrobial and 35 (38.5%) were polymicrobial. A total of 132 bacterial isolates were recovered.

Gram-negative organisms predominated, accounting for 84 (63.6%) isolates, whereas Gram-positive organisms constituted 48 (36.4%). *Staphylococcus aureus* was the most frequently isolated individual organism (25.0%), followed by *Escherichia coli* (18.2%), *Pseudomonas aeruginosa* (15.9%), *Klebsiella pneumoniae* (13.6%), *Proteus* spp. (9.1%), and *Enterococcus* spp. (7.6%) (Table 3, Figure 3).

Table 3. Microbiological profile of diabetic foot infections

| Microbiological finding             | n (%)     |
|-------------------------------------|-----------|
| Culture-positive patients (n=100)   | 91 (91.0) |
| Culture-negative patients (n=100)   | 9 (9.0)   |
| Monomicrobial infection (n=91)      | 56 (61.5) |
| Polymicrobial infection (n=91)      | 35 (38.5) |
| Organisms isolated (n=132 isolates) |           |
| <i>Staphylococcus aureus</i>        | 33 (25.0) |
| <i>Escherichia coli</i>             | 24 (18.2) |
| <i>Pseudomonas aeruginosa</i>       | 21 (15.9) |
| <i>Klebsiella pneumoniae</i>        | 18 (13.6) |
| <i>Proteus</i> spp.                 | 12 (9.1)  |
| <i>Enterococcus</i> spp.            | 10 (7.6)  |
| Coagulase-negative staphylococci    | 5 (3.8)   |
| Other Gram-negative organisms       | 9 (6.8)   |
| Gram-positive isolates              | 48 (36.4) |
| Gram-negative isolates              | 84 (63.6) |

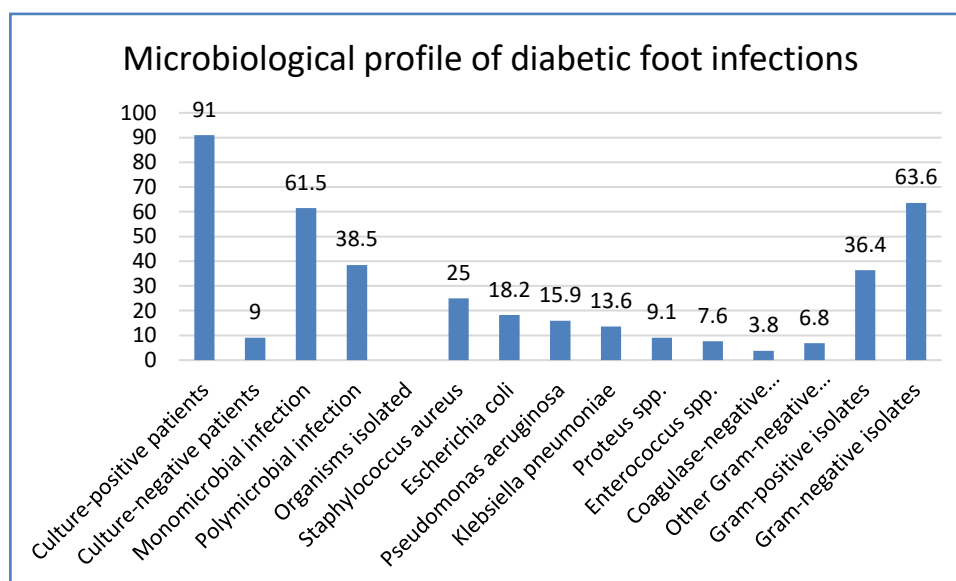


Figure 3 Microbiological profile of diabetic foot infections

Multidrug resistance was identified in 48 (36.4%) of the 132 bacterial isolates. Among the 33 *S. aureus* isolates, 12 (36.4%) were methicillin-resistant *S. aureus* (MRSA). ESBL production was detected in 19 (35.2%) of 54 *E. coli* and *K. pneumoniae* isolates. Carbapenem resistance was observed in 14 (16.7%) of the 84 Gram-negative isolates.

MDR organisms were more frequently recovered from patients with previous antibiotic exposure and advanced Wagner grades. Among patients with Wagner Grade  $\geq 3$  infection, 39 (58.2%) had at least one MDR isolate compared with 9 (27.3%) among those with Wagner Grade 1–2 disease ( $p=0.004$ ) (Table 4).

Table 4. Antimicrobial resistance pattern and association with severity

| Resistance characteristic                            | n/N (%)       |
|------------------------------------------------------|---------------|
| MDR isolates                                         | 48/132 (36.4) |
| MRSA among <i>S. aureus</i>                          | 12/33 (36.4)  |
| ESBL among <i>E. coli</i> + <i>K. pneumoniae</i>     | 19/54 (35.2)  |
| Carbapenem-resistant Gram-negative isolates          | 14/84 (16.7)  |
| Patients with MDR organism according to Wagner grade |               |
| Wagner Grade 1–2 (n=33)                              | 9 (27.3)      |
| Wagner Grade $\geq 3$ (n=67)                         | 39 (58.2)     |
| p-value                                              | 0.004         |

MDR: multidrug-resistant; MRSA: methicillin-resistant *Staphylococcus aureus*; ESBL: extended-spectrum  $\beta$ -lactamase.

Histopathological examination demonstrated acute suppurative inflammation in 61.0% of specimens, chronic inflammatory changes in 58.0%, granulation tissue in 63.0%, and tissue necrosis in 52.0%. Microvascular changes were observed in 42.0% of specimens. Histopathological evidence of osteomyelitis was identified in 27.0% of patients.

Advanced Wagner grade was significantly associated with tissue necrosis and histopathologically confirmed osteomyelitis. Tissue necrosis was observed in 44 (65.7%) patients with Wagner Grade  $\geq 3$  compared with 8 (24.2%) patients with Grade 1–2 disease ( $p < 0.001$ ). Histopathological osteomyelitis was present in 25 (37.3%) patients with Grade  $\geq 3$  disease compared with 2 (6.1%) patients with Grade 1–2 disease ( $p = 0.001$ ) (Table 5).

Table 5. Histopathological findings and their association with Wagner grade

| Histopathological finding      | Grade 1–2 (n=33) | Grade $\geq 3$ (n=67) | Total (n=100) | p-value |
|--------------------------------|------------------|-----------------------|---------------|---------|
| Acute suppurative inflammation | 14 (42.4)        | 47 (70.1)             | 61 (61.0)     | 0.008   |
| Chronic inflammation           | 16 (48.5)        | 42 (62.7)             | 58 (58.0)     | 0.176   |
| Granulation tissue             | 19 (57.6)        | 44 (65.7)             | 63 (63.0)     | 0.429   |
| Tissue necrosis                | 8 (24.2)         | 44 (65.7)             | 52 (52.0)     | <0.001  |
| Microvascular changes          | 10 (30.3)        | 32 (47.8)             | 42 (42.0)     | 0.096   |
| Osteomyelitis                  | 2 (6.1)          | 25 (37.3)             | 27 (27.0)     | 0.001   |

Values are presented as n (%).

Debridement alone was sufficient in 47 (47.0%) patients, whereas 31 (31.0%) underwent minor amputation involving the toe, ray, or forefoot. Major lower-extremity amputation was required in 12 (12.0%) patients, while 10 (10.0%) underwent other procedures, including incision and drainage with subsequent staged debridement. Repeated debridement was required in 29.0% of patients.

The requirement for amputation increased significantly with disease severity. Among patients with Wagner Grade 1–2 disease, 5 (15.2%) underwent either minor or major amputation compared with 38 (56.7%) patients with Wagner Grade  $\geq 3$  disease ( $p < 0.001$ ). Similarly, amputation was significantly more frequent among patients with MDR infection, histopathological osteomyelitis, peripheral arterial disease, and tissue necrosis (Table 6).

Table 6. Association of clinical, microbiological and pathological factors with amputation

| Factor                       | Amputation present | No amputation | p-value |
|------------------------------|--------------------|---------------|---------|
| Wagner Grade 1–2 (n=33)      | 5 (15.2)           | 28 (84.8)     | <0.001  |
| Wagner Grade $\geq 3$ (n=67) | 38 (56.7)          | 29 (43.3)     |         |
| MDR infection present (n=48) | 29 (60.4)          | 19 (39.6)     | <0.001  |
| MDR infection absent (n=52)  | 14 (26.9)          | 38 (73.1)     |         |
| Osteomyelitis present (n=27) | 20 (74.1)          | 7 (25.9)      | <0.001  |

Clinicopathological and microbiological correlation of diabetic foot infections in patients undergoing surgical

|                                            |           |           |        |
|--------------------------------------------|-----------|-----------|--------|
| Osteomyelitis absent (n=73)                | 23 (31.5) | 50 (68.5) |        |
| Peripheral arterial disease present (n=34) | 22 (64.7) | 12 (35.3) | 0.002  |
| Peripheral arterial disease absent (n=66)  | 21 (31.8) | 45 (68.2) |        |
| Tissue necrosis present (n=52)             | 31 (59.6) | 21 (40.4) | <0.001 |
| Tissue necrosis absent (n=48)              | 12 (25.0) | 36 (75.0) |        |

## DISCUSSION

Diabetic foot infection (DFI) is a major complication of diabetes mellitus and is associated with prolonged hospitalization, repeated surgical procedures, antimicrobial resistance, and lower-extremity amputation. The present study evaluated 100 patients with DFI undergoing surgical management and correlated clinical severity, microbiological profile, histopathological changes, antimicrobial resistance, and surgical outcomes. The mean age of patients was  $56.8 \pm 10.9$  years, and 34.0% belonged to the 51–60-year age group. Males predominated (72.0%). These findings were comparable with those of Saseedharan et al. [13] who reported a mean age of approximately 58 years, with 59.7% males among patients with diabetic foot infections. The predominance of middle-aged and elderly patients may reflect the cumulative effect of longstanding diabetes, neuropathy, vascular impairment, and delayed wound healing. The mean duration of diabetes was  $10.6 \pm 6.2$  years, while 68.0% of patients had HbA1c  $\geq 8\%$ , indicating poor glycaemic control. Peripheral neuropathy was present in 69.0%, whereas peripheral arterial disease (PAD) was observed in 34.0%. Importantly, amputation occurred in 64.7% of patients with PAD compared with 31.8% without PAD ( $p=0.002$ ). This was consistent with a multicentre study of 526 patients in which PAD independently predicted amputation with an adjusted OR of 1.554 (95% CI 1.030–2.345). Most patients presented with advanced disease. Wagner Grade 3, 4, and 5 ulcers were observed in 35.0%, 24.0%, and 8.0%, respectively, and overall 67.0% had Wagner Grade  $\geq 3$ . Amputation was required in 56.7% of patients with Wagner Grade  $\geq 3$  compared with 15.2% with Grades 1–2 ( $p<0.001$ ). Similar findings were reported in the multicentre study, where Wagner Grade 3 was associated with an OR of 1.787 for amputation, while Grades 4–5 had an OR of 4.272. This confirms the prognostic importance of clinical grading in diabetic foot disease. Microbiological cultures were positive in 91.0% of patients. Among culture-positive cases, 61.5% were monomicrobial and 38.5% were polymicrobial. Saseedharan et al. [13] reported polymicrobial infection in 55.7%, while another study involving 104 patients reported a rate of 28.8%. Such differences may be influenced by ulcer chronicity, prior antibiotic exposure, disease severity, and specimen collection methods. Gram-negative organisms predominated in our study, accounting for 63.6% of isolates, while Gram-positive organisms represented 36.4%. This pattern was similar to Saseedharan et al. [13] who reported 58.5% Gram-negative and 41.5% Gram-positive organisms, and another study reporting 62% Gram-negative isolates. *Staphylococcus aureus* was the most frequent individual organism in our study (25.0%), followed by *Escherichia coli* (18.2%), *Pseudomonas aeruginosa* (15.9%), and *Klebsiella pneumoniae* (13.6%). Saseedharan et al. [13] similarly reported *S. aureus* as the commonest isolate (26.9%). Multidrug resistance was identified in 36.4% of isolates. MRSA accounted for 36.4% of *S. aureus* isolates, ESBL production was present in 35.2% of *E. coli* and *K. pneumoniae*, and carbapenem resistance was observed in 16.7% of Gram-negative isolates. Saseedharan et al. [13] reported MRSA in 23.7%, ESBL production in 43.1%, and carbapenem resistance in 16.8% of Enterobacteriaceae. In the present study, MDR organisms were significantly more common in Wagner Grade  $\geq 3$  disease than in Grades 1–2 (58.2% vs 27.3%;  $p=0.004$ ), suggesting an association between advanced disease and resistant infection.

Histopathological examination showed acute suppurative inflammation in 61.0%, tissue necrosis in 52.0%, and osteomyelitis in 27.0%. Tissue necrosis and osteomyelitis were significantly more frequent in Wagner Grade  $\geq 3$  disease. Moreover, 74.1% of patients with osteomyelitis required amputation compared with 31.5% without osteomyelitis ( $p < 0.001$ ). Published evidence similarly indicates that bone involvement substantially increases the risk of amputation. Regarding surgical outcome, 47.0% underwent debridement alone, 31.0% minor amputation, and 12.0% major amputation, giving an overall amputation rate of 43.0%. Saseedharan et al. [13] reported an amputation rate of 55.5%. In our study, amputation was significantly associated with advanced Wagner grade, MDR infection, PAD, tissue necrosis, and osteomyelitis.

## CONCLUSION

Diabetic foot infections were frequently associated with advanced clinical disease, multidrug-resistant organisms, tissue necrosis, osteomyelitis, and a substantial risk of amputation. Gram-negative organisms predominated, with *Staphylococcus aureus* remaining the most common individual isolate. Higher Wagner grade, peripheral arterial disease, MDR infection, necrosis, and osteomyelitis were significantly associated with adverse surgical outcomes. An integrated clinicopathological and microbiological assessment can therefore support early risk stratification, appropriate antimicrobial therapy, timely surgical intervention, and improved limb-salvage outcomes.

## LIMITATIONS

The study was limited by its relatively small sample size and single-centre design, which may restrict the generalizability of the findings. The microbiological profile and antimicrobial resistance patterns may vary across different geographical regions and healthcare settings. The limited duration of follow-up prevented assessment of long-term outcomes such as ulcer recurrence, re-infection, wound healing, and subsequent amputation. Larger multicentre studies with longer follow-up are required to validate these findings.

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