International Journal of Life Sciences, Biotechnology and Pharma Research Vol. 14, No. 3, March 2025 Online ISSN: 2250-3137
Print ISSN: 2977-0122

DOI: 10.69605/ijlbpr_14.3.2025.65

ORIGINAL RESEARCH

Evaluation and Management of Diabetic Foot according to Wagener's Classification

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Received: 26 January, 2025 Accepted: 28 February, 2025 Published: 10 March, 2025

Abstract
Background: Diabetic foot ulcers (DFUs) are a major complication of diabetes mellitus, often leading to lower limb amputations. Wagner's Classification is widely used for grading DFUs based on depth, infection, and gangrene severity. This study aims to evaluate the clinical profile, microbial spectrum, treatment modalities, and outcomes of diabetic foot patients based on Wagner's Classification. **Methods:** A prospective observational study was conducted on 67 patients with diabetic foot ulcers. Data on demographic details, clinical presentation, microbial isolates, treatment strategies, and outcomes were recorded. Patients were classified according to Wagner's system and managed accordingly. Follow-up was done at 1, 4, and 12 weeks to assess healing status. **Results:** Males (65.7%) were predominantly affected, with the highest incidence in the 40–50 years age group (29.9%). Ulcers (53.7%) were the most common presentation. The microbial analysis identified Staphylococcus aureus (28.4%) and Pseudomonas (23.9%) as the predominant pathogens. Most cases were Wagner's Grade II (43.3%), followed by Grade I (25.4%) and Grade III (16.4%). Treatment involved debridement (37.3%), antibiotics (26.9%), and amputation (11.9%). Complete healing improved from 7.5% at 1 week to 53.7% at 12 weeks. Factors significantly influencing healing included age <60 years, non-smoking status, and blood sugar <200 mg/dL ($p<0.001$).**Conclusion:** Wagner's Classification plays a vital role in guiding diabetic foot management. Early intervention, glycemic control, and appropriate infection management significantly improve outcomes and reduce amputation rates.
Keywords: Diabetic foot, Wagner's Classification, ulcers, infection, debridement, glycemic control, amputation.

Introduction

Diabetes mellitus is a chronic metabolic disorder characterized by persistent hyperglycemia, leading to multiple microvascular and macrovascular complications. Among these, diabetic foot complications represent a major cause of morbidity and lower extremity amputations worldwide [1]. Diabetic foot results from a complex interplay of peripheral neuropathy, peripheral arterial disease, and infection, which culminates in chronic non-healing ulcers and gangrene [2]. It is estimated that approximately 15% of diabetic patients develop foot ulcers during their lifetime, with a significant proportion progressing to severe infections and amputations [3].

Several classification systems have been proposed to stratify the severity of diabetic foot disease, including the Wagner-Meggitt classification, the University of Texas system, and the PEDIS system. Among these, Wagner's Classification is one of the most widely used for grading diabetic foot ulcers based on depth, infection, and gangrene, aiding in risk stratification and treatment planning [4]. The Wagner system, introduced in 1976, categorizes diabetic foot ulcers into six grades (0–5), ranging from intact skin to extensive gangrene [5]. This classification is crucial for guiding clinical decisions, determining prognosis, and evaluating treatment outcomes [6]. The management of diabetic foot ulcers involves a multidisciplinary approach that includes glycemic control, infection management, wound care, revascularization procedures, and surgical interventions [7]. Early detection and appropriate classification using Wagner's system can significantly improve patient outcomes by enabling timely and

DOI: 10.69605/ijlbpr_14.3.2025.65

targeted therapeutic interventions [8]. Moreover, preventive strategies such as patient education, proper footwear, and routine foot examinations play a critical role in reducing the incidence of foot ulcers and amputations in diabetic individuals [9].

This study aims to evaluate and manage diabetic foot ulcers based on Wagner's Classification, emphasizing its role in guiding treatment strategies and improving patient outcomes. By analyzing the clinical progression and response to different management approaches, this research seeks to contribute to the optimization of diabetic foot care and reduce the burden of lower extremity amputations.

Materials and Method

This was a prospective observational study conducted at the Department of Surgery of Government Medical college, (Singareni Institute of Medical Sciences) Ramagundamfor the duration of one year. The study was designed to evaluate the severity, management, and outcomes of diabetic foot ulcers based on **Wagner's**

Classification. Ethical approval was obtained from the Institutional Ethics Committee. Written informed consent was obtained from all participants before inclusion in the study.

Inclusion Criteria

Patients diagnosed with **diabetic foot ulcers** fulfilling the following criteria were included:

1. Age ≥ 18 years with a confirmed diagnosis of diabetes mellitus (Type 1 or Type 2).
2. Presence of diabetic foot ulcer with a Wagner Grade ≥ 1.
3. Patients willing to participate and provide informed consent.

Exclusion Criteria

1. Patients with non-diabetic foot ulcers (e.g., venous ulcers, arterial ulcers unrelated to diabetes).
2. Those with severe systemic infections, septicemia, or critical illness preventing participation.
3. Patients with prior major lower limb amputation (above the ankle).
4. Pregnant or lactating women.

Sample Size Calculation

The sample size was determined based on the prevalence of diabetic foot ulcers reported in previous studies, with a 95% confidence interval and 5% margin of error. A total of 67 patients were recruited.

Clinical and Laboratory Assessment

Each patient underwent a detailed clinical evaluation, including:

- Demographic data: Age, sex, duration of diabetes, comorbidities.
- Ulcer assessment: Wagner's Classification was used to grade ulcers as follows:
  - Grade 0: No open lesion (pre-ulcerative lesion or healed ulcer).
  - Grade 1: Superficial ulcer without deep tissue involvement.
  - Grade 2: Deep ulcer extending to tendon, joint, or capsule.
  - Grade 3: Ulcer with osteomyelitis or deep abscess.
  - Grade 4: Partial gangrene of the forefoot.
  - Grade 5: Extensive gangrene of the entire foot.
- Peripheral neuropathy evaluation using 10g monofilament test, vibration perception test (128 Hz tuning fork), and ankle reflex testing.
- Peripheral arterial disease (PAD) assessment using Ankle-Brachial Index (ABI) and Doppler ultrasound.
- Wound infection evaluation using wound swab cultures and sensitivity testing.
- Glycemic control assessment through fasting blood glucose (FBG), postprandial blood glucose (PPBG), and HbA1c levels.

Management Approach

Standard Treatment Protocol

All patients received treatment based on the Wagner grade of their ulcer:

Wagner Grade	Treatment Approach
Grade 0	Foot care education, preventive footwear.
Grade 1	Wound debridement, dressing with antimicrobial agents, glycemic control.
Grade 2	Broad-spectrum antibiotics (based on culture sensitivity), offloading techniques (e.g., total contact casting).
Grade 3	Surgical debridement, drainage of abscess, IV antibiotics, hospitalization if necessary.
Grade 4	Partial foot amputation, vascular intervention if indicated.
Grade 5	Major amputation (below-knee or above-knee) after vascular assessment.

- **Antibiotic therapy**: Empirical antibiotics were initiated and adjusted according to **culture and sensitivity reports**.
- **Wound care**: Dressings included **silver-based, hydrocolloid, and collagen-based materials**.
- **Offloading techniques**: Patients with neuropathic ulcers were advised **total contact**

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casting, removable cast walkers, or custom footwear.

- **Revascularization**: Patients with **severe PAD (ABI < 0.5)** were referred for **angioplasty or bypass surgery**.
- **Surgical intervention**: Patients with **extensive gangrene or osteomyelitis** underwent **debridement, minor amputation (toe/forefoot), or major amputation** based on vascular status.

Follow-Up and Outcome Assessment

Patients were followed at **1-week, 4-weeks, and 12-weeks** to monitor ulcer healing, infection resolution, and amputation rates. Healing was defined as **complete epithelialization** without signs of infection. Treatment success was categorized as:

- **Complete healing**: Wound closure with epithelialization.
- **Partial healing**: Reduction in ulcer size by ≥50%.
- **Non-healing**: No significant improvement despite treatment.
- **Amputation**: Minor (toe/forefoot) or major (below/above knee).

Statistical Analysis

Data were analyzed using SPSS version 25. Continuous variables were expressed as mean ± standard deviation (SD) and categorical variables as percentages (%). Comparisons between groups were performed using:

- Chi-square test for categorical data.
- Statistical significance was set at $p < 0.05$.

Observation and Results

The Observation and Results section of the study consists of five tables presenting different aspects of the study population, their clinical presentation, treatment, and outcomes.

Table 1: Demographic profile distribution among study population

Parameters	Frequency	Percentages
Gender		
Male	44	65.7
Female	23	34.3
Age		
40 - 50 Years	20	29.9
51 - 60 Years	17	25.4
61 - 70 Years	17	25.4
71 - 80 Years	13	19.4
Habits		
Smoking	22	32.8
Alcohol	13	19.4
Both	15	22.4
None	17	25.4
Comorbid Condition		
CKD	10	14.9
Hypertension	17	25.4
Multiple	9	13.4
Neuropathy	11	16.4
None	17	25.4
PAD	3	4.5

This table provides an overview of the study population's demographic characteristics. It includes gender distribution, where males constitute a larger proportion (65.7%) than females (34.3%). The age distribution shows that the majority of participants fall between 40–80 years, with the highest representation in the 40–50 years (29.9%) group. The study also examines habits such as smoking (32.8%), alcohol consumption (19.4%), both smoking and alcohol use (22.4%), or none (25.4%). Additionally, the prevalence of comorbid conditions is detailed, including hypertension (25.4%), chronic kidney disease (14.9%), neuropathy (16.4%), multiple conditions (13.4%), and peripheral arterial disease (PAD) (4.5%), while 25.4% had no comorbidities.

Table 2: Distribution of mode of presentation and others among study population

Parameters	Frequency	Percentages
Mode of Presentation		
Abscess	8	11.9
Cellulitis	7	10.4
Gangrene	16	23.9

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Ulcer	36	53.7
Site of Lesion		
Dorsum	8	11.9
Forefoot	7	10.4
Heel	17	25.4
Multiple	9	13.4
Toe	26	38.8
H/o Previous Ulcer		
Yes	19	28.4
No	48	71.6

This table outlines how participants presented clinically. The most common mode of presentation was ulcers (53.7%), followed by gangrene (23.9%), abscesses (11.9%), and cellulitis (10.4%). The site of lesions varied, with the highest occurrence in toes (38.8%), followed by the heel (25.4%), multiple sites (13.4%), dorsum (11.9%), and forefoot (10.4%). A significant proportion (71.6%) of participants had no prior history of ulcers, while 28.4% had a previous ulcer.

Table 3: Distribution of treatment details among study population

Parameters	Frequency	Percentages
Isolated Organism		
E. coli	12	17.9
Polymicrobial	15	22.4
Pseudomonas	16	23.9
Staph Aureus	19	28.4
No Growth	5	7.5
Wagner's Class		
Grade I	17	25.4
Grade II	29	43.3
Grade III	11	16.4
Grade IV	7	10.4
Grade IV	3	4.5
Treatment Done		
Amputation	8	11.9
Antibiotics	18	26.9
Debridement	25	37.3
Offloading	8	11.9
Revascularization	8	11.9
Resurgery		
Yes	7	10.4
No	60	89.6

The study examined the microbial profile and treatment interventions. The most commonly isolated organism was Staphylococcus aureus (28.4%), followed by Pseudomonas (23.9%), polymicrobial infections (22.4%), E. coli (17.9%), and cases with no bacterial growth (7.5%). Wagner's classification of wounds revealed that the majority were Grade II (43.3%), followed by Grade I (25.4%), Grade III (16.4%), Grade IV (10.4%), and the least being Grade V (4.5%). Regarding treatment modalities, debridement was the most frequently performed intervention (37.3%), followed by antibiotic therapy (26.9%), amputation (11.9%), offloading (11.9%), and revascularization (11.9%). Only 10.4% of patients required resurgery, while 89.6% did not.

Table 4 : Outcome distribution among study population

Parameters	At 1 Week	At 4th Week	At 12th Week
Complete Healing	5(7.5%)	12(17.9%)	36(53.7%)
Partial Healing	33(49.3%)	27(40.3%)	19(28.4%)
No Healing	22(32.8%)	21(31.3%)	6(9%)
Amputation	7(10.4%)	7(10.4%)	6(9%)

This table tracks patient outcomes over time at 1 week, 4 weeks, and 12 weeks. Complete healing improved from 7.5% at 1 week to 53.7% at 12 weeks. Partial healing decreased from 49.3% at 1 week to 28.4% at 12

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weeks. The percentage of patients showing no healing reduced from 32.8% at 1 week to 9% at 12 weeks. Amputation rates remained relatively stable over time, with 10.4% undergoing amputation at 1 and 4 weeks, decreasing slightly to 9% at 12 weeks.

Table 5: Factors associated with outcome after 3 months

Parameters	Followed Up after 3 Months		Chi-square	p-value
	Healed	Unhealed		
Age				
< 60 Years	34(50.7%)	3(4.5%)	39.2	<0.001
> 60 Years	2(3.0%)	28(41.8%)		
History of Smoking				
Yes	3(4.5%)	19(28.4%)	21.18	<0.001
No	33(49.3%)	12(17.9%)		
Blood Sugar During Admission				
< 200	28(41.8%)	10(14.9%)	14.05	0.00017
> 200	8(11.9%)	21(31.3%)		

The final table assesses factors influencing healing at 3 months using statistical analysis. Age was significantly associated with healing outcomes; patients younger than 60 years had a significantly higher healing rate (50.7%) than those above 60 years (3.0%), with a p-value < 0.001. A history of smoking was another critical factor; non-smokers had a higher healing rate (49.3%) compared to smokers (4.5%), with a p-value < 0.001. Additionally, blood sugar levels at admission influenced outcomes; patients with blood sugar <200 mg/dL had better healing (41.8%) compared to those with blood sugar >200 mg/dL (11.9%), with a p-value of 0.00017.

Discussion

Diabetic foot ulcers (DFUs) remain a significant cause of morbidity and mortality among diabetic patients, requiring a multidisciplinary approach for effective management. This study evaluated the demographic profile, clinical presentation, microbiological spectrum, treatment strategies, and outcomes of patients with diabetic foot lesions according to Wagner's classification. Our findings were compared with other Indian studies to provide a broader perspective on diabetic foot management.

Demographic and Clinical Characteristics

In our study, males (65.7%) were more affected than females (34.3%), a finding consistent with Indian studies by Bansal et al. [10] and Karthikeyan et al. [11], where male preponderance was observed. The highest incidence was in the 40–50 years age group (29.9%), followed by 51–60 years (25.4%). The presence of comorbidities, particularly hypertension (25.4%), chronic kidney disease (14.9%), and neuropathy (16.4%), aligns with findings from a study by Jain et al. [12], where neuropathy was a major risk factor.

Mode of Presentation and Site of Lesions

Ulcers were the most common presentation (53.7%), followed by gangrene (23.9%), abscesses (11.9%), and cellulitis (10.4%). A similar pattern was noted by Chandan et al. [13], who reported ulcers as the predominant manifestation in 56% of cases. The most affected site in our study was the toe (38.8%), followed by the heel (25.4%). This distribution is in concordance with a study by Ramachandran et al. [14], highlighting the toes as the most common site due to pressure points and neuropathy.

Microbial Profile

Microbiological analysis revealed Staphylococcus aureus (28.4%) as the most frequently isolated organism, followed by Pseudomonas (23.9%), polymicrobial infections (22.4%), and E. coli (17.9%). This pattern is comparable to studies by Rajalakshmi et al. [15], where Staphylococcus aureus was dominant in 30% of cases. Polymicrobial infections were also significant in our study, emphasizing the necessity of broad-spectrum antibiotics.

Wagner's Classification and Treatment Modalities

The majority of our cases were classified as Wagner's Grade II (43.3%), followed by Grade I (25.4%) and Grade III (16.4%). A similar trend was observed in a study by Agarwal et al. [16], where Grade II was predominant. Treatment modalities included debridement (37.3%), antibiotics (26.9%), amputation (11.9%), offloading (11.9%), and revascularization (11.9%). Our amputation rate (11.9%) is lower than the 15–20% reported in other Indian studies [17], which may reflect early intervention and better infection control.

Outcomes and Prognostic Factors

Complete healing improved from 7.5% at 1 week to 53.7% at 12 weeks, demonstrating the effectiveness of treatment. Factors significantly associated with healing at 3 months included age <60 years ($p < 0.001$), non-smoking status ($p < 0.001$), and blood sugar <200 mg/dL ($p = 0.00017$). A study by Mishra et al. [18] also identified smoking and hyperglycemia as major risk factors for poor healing.

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Comparison with Other Indian Studies

Our findings align with national trends, emphasizing the high burden of diabetic foot complications in India. Studies by Sharma et al. [19] and Joshi et al. [20] also highlighted the role of early wound care, offloading strategies, and glycemic control in improving outcomes. The lower amputation rate in our study compared to older studies suggests improvements in management strategies over time.

Conclusion

This study underscores the significance of early detection, appropriate microbial management, aggressive wound care, and metabolic control in diabetic foot care. While our findings are consistent with other Indian studies, variations in treatment outcomes highlight the need for standardized protocols and better patient education programs to reduce the burden of diabetic foot complications in India.

Acknowledgement : None
Conflict of Interest : None

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