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Original Research Article

Evaluation management of diabetic foot ulcers according to Wagner's classification in a tertiary care hospital in Northern India

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ABSTRACT

Background: Diabetic foot ulcer (DFU) is among the most severe and disabling complications of diabetes mellitus and represents a major cause of hospitalization, morbidity, lower limb amputation, and mortality worldwide. The incidence of diabetic foot complications is increasing rapidly in developing countries such as India due to rising diabetes prevalence, poor glycemic control, delayed healthcare access, and lack of foot care awareness. Wagner's classification remains one of the most practical and widely accepted systems for evaluating diabetic foot ulcers and guiding treatment strategies. Early diagnosis and stage-appropriate intervention are essential for reducing complications and improving limb salvage rates.

Methods: This prospective observational study was conducted among 70 patients with diabetic foot ulcers admitted to the Department of General Surgery in a tertiary care hospital in Northern India over a period of 18 months. Detailed demographic data, duration of diabetes, associated comorbidities, glycaemic status, ulcer characteristics, microbiological profile, and radiological findings were recorded. Ulcers were graded according to Wagner's classification system. Patients received medical and surgical management including glycaemic control, antibiotics, debridement, incision and drainage, skin grafting, and amputations where indicated. Outcomes were evaluated in terms of ulcer healing, duration of hospital stay, and amputation rates.

Results: The majority of patients were males (68.6%) with a mean age of 56.8±10.4 years. Wagner Grade II ulcers were most common (34.3%), followed by Grade III ulcers (28.6%). Peripheral neuropathy was observed in 71.4% of patients and poor glycemic control in 74.3%. Surgical intervention was required in 61.4% cases, with debridement being the most commonly performed procedure. Major amputations were more common in Wagner Grade IV and V ulcers. Increasing Wagner grade showed significant association with prolonged hospitalization and increased amputation rates ($p<0.05$).

Conclusions: Wagner's classification is an effective and reliable tool for assessing severity and guiding management of diabetic foot ulcers. Early diagnosis, strict glycemic control, aggressive infection management, regular wound care, and timely surgical intervention are essential to improve outcomes and reduce limb loss.

Keywords: Diabetic foot ulcer, Wagner classification, Diabetes mellitus, Amputation, Debridement, Peripheral neuropathy, Tertiary care hospital

INTRODUCTION

Diabetes mellitus is a chronic metabolic disorder characterized by persistent hyperglycaemia resulting from defects in insulin secretion, insulin action, or both. It has emerged as one of the leading global public health challenges of the twenty-first century. According to the International diabetes federation, nearly 537 million adults were living with diabetes worldwide in 2021, and this number is projected to rise substantially over the coming decades. India contributes significantly to this burden and is often referred to as the "diabetes capital of the world."[1,2]

Among the various complications of diabetes mellitus, Diabetic foot ulcer (DFU) is one of the most feared and economically devastating complications because of its association with prolonged hospitalization, recurrent infections, disability, and lower limb amputations. Approximately 15-25% of diabetic individuals develop a foot ulcer during their lifetime, and every 20 seconds a lower limb is amputated somewhere in the world due to diabetes-related complications.[3,4]

Diabetic foot is defined as infection, ulceration, or destruction of deep tissues of the foot associated with neuropathy and/or peripheral arterial disease in patients with diabetes mellitus. The pathogenesis of diabetic foot ulcers is multifactorial and involves peripheral sensory neuropathy, autonomic dysfunction, motor neuropathy, peripheral vascular disease, immunopathy, repetitive trauma, foot deformities, and secondary infection.[5,6] Peripheral neuropathy plays a central role by causing loss of protective sensation, leading to repeated unnoticed trauma and pressure-related tissue breakdown. In developing countries such as India, poor socioeconomic conditions, barefoot walking, delayed medical consultation, poor glycaemic control, and lack of awareness regarding diabetic foot care contribute significantly to disease progression and increased amputation rates. Indian studies have reported diabetic foot ulcer prevalence ranging from 4% to 10%, with a substantially higher incidence of infection and gangrene compared to Western populations.[7,8]

The burden of diabetic foot disease is particularly severe in Northern India due to limited healthcare accessibility in rural areas and delayed referrals to tertiary care centres. Many patients present at advanced stages with deep ulcers, osteomyelitis, abscess formation, or gangrene requiring major surgical intervention. Early assessment and classification of ulcers are therefore essential for selecting appropriate management strategies and predicting outcomes.[9]

Several classification systems have been proposed for diabetic foot ulcers, including Wagner-Meggitt classification, University of Texas classification, and PEDIS classification. Among these, Wagner's classification remains one of the simplest and most widely used grading systems in routine surgical practice because of its clinical applicability and prognostic significance.[10]

Wagner classification grades 0 to 5

Wagner grade 0 denotes an intact high-risk foot, while grade V represents extensive gangrene involving the whole foot. Increasing Wagner grades correlate strongly with deeper tissue involvement, severe infection, osteomyelitis, higher amputation rates, and poor prognosis.[11,12]

Management of diabetic foot ulcers requires a multidisciplinary approach involving strict glycaemic control, antibiotic therapy, wound debridement, pressure off-loading, vascular assessment, infection control, and reconstructive or ablative surgical procedures wherever indicated. Timely intervention can significantly reduce morbidity and improve limb salvage rates.[13,14]

Despite advances in diabetic care, diabetic foot ulcer remains a major healthcare burden in India, particularly in tertiary care hospitals managing advanced complicated cases. Therefore, the present study was undertaken to evaluate the clinical presentation, management strategies, and outcomes of DFU according to Wagner's classification among 70 patients admitted to a tertiary care hospital in Northern India.

METHODS

This prospective observational study was conducted in the Department of General Surgery at a tertiary care teaching hospital in Northern India over a period of 18 months after obtaining approval from the Institutional Ethics Committee.

Table 1: Classification of ulcers according to Wagner's grading system.

Wagner grades	Description
Grade 0	Intact skin with high-risk foot
Grade I	Superficial ulcer
Grade II	Deep ulcer reaching tendon or joint
Grade III	Deep ulcer with abscess or osteomyelitis
Grade IV	Localized gangrene
Grade V	Extensive gangrene of foot

A total of 70 patients diagnosed clinically with diabetic foot ulcers were included in the study after obtaining informed written consent. Patients were selected irrespective of gender, duration of diabetes, or socioeconomic status.

Inclusion criteria

The study included patients aged above 18 years who were diagnosed with either type 1 or type 2 diabetes mellitus and had the presence of a diabetic foot ulcer.

Exclusion criteria

The study excluded patients with non-diabetic foot ulcers, venous ulcers, malignant ulcers, and traumatic ulcers unrelated to diabetes, as well as patients who were unwilling to participate in the study. Detailed history regarding age, gender, occupation, duration of diabetes, smoking history, alcohol intake, barefoot walking habits, trauma, previous ulcer history, and associated comorbidities was recorded. Complete general physical

examination and detailed local examination of the affected foot were performed.

All patients underwent detailed laboratory and radiological investigations, including a complete blood count, random blood sugar and fasting blood sugar estimation, HbA1c estimation, renal function tests, urine routine examination, pus culture and sensitivity testing, and X-ray examination of the affected foot. A doppler ultrasound study was performed in patients where clinically indicated. Peripheral neuropathy was assessed clinically using monofilament testing and vibration perception. Peripheral vascular disease was evaluated by palpation of peripheral pulses and doppler assessment.

Patients were managed according to ulcer severity. Glycemic control was achieved using insulin therapy wherever necessary. Empirical broad-spectrum antibiotics were initiated initially and later modified according to culture sensitivity reports. Daily wound dressing, pressure off-loading, and nutritional support were provided. The surgical interventions performed included debridement, incision and drainage, fasciotomy, skin grafting, minor amputation, and major amputation.

Patients were followed during hospitalization and outcomes were assessed in terms of ulcer healing, need for amputation, complications, and duration of hospital stay. Statistical analysis was performed using SPSS software version 26. Continuous variables were expressed as mean±standard deviation and categorical variables as percentages. Chi-square test was applied to determine statistical significance. A p value <0.05 was considered statistically significant.

RESULTS

A total of 70 patients with diabetic foot ulcers were included in the present study. Detailed demographic evaluation, ulcer grading according to Wagner's classification, associated risk factors, treatment modalities, and clinical outcomes were analysed systematically.

Table 2: Age distribution of patients.

Age groups (years)	Number of patients (N)	Percentage (%)	P value
31-40	8	11.4	0.032 (S)
41-50	16	22.9	
51-60	24	34.3	
61-70	15	21.4	
>70	7	10.0	
Total	70	100	

The mean age of the study population was 56.8±10.4 years. Male patients constituted the majority of cases. Most patients presented with long-standing uncontrolled diabetes mellitus and associated neuropathic complications. Wagner grade II and III ulcers were the most commonly encountered lesions at the time of admission. A significant proportion of patients required surgical intervention, and the risk of amputation increased progressively with higher Wagner grades.

Table 3: Gender distribution.

Genders	Number of patients (N)	Percentage (%)	P value
Male	48	68.6	0.018 (S)
Female	22	31.4	
Total	70	100	

Table 4: Duration of diabetes mellitus.

Duration of diabetes (years)	Number of patients (N)	Percentage (%)	P value
<5	10	14.3	0.006 (S)
5-10	24	34.3	
11-15	20	28.6	
>15	16	22.9	
Total	70	100	

Table 5: Distribution according to Wagner's classification.

Wagner grades	Number of patients (N)	Percentage (%)	P value
Grade I	12	17.1	0.001 (S)
Grade II	24	34.3	
Grade III	20	28.6	
Grade IV	10	14.3	
Grade V	4	5.7	
Total	70	100	

Table 6: Associated risk factors.

Risk factors	Number of patients (N)	Percentage (%)	P value
Peripheral neuropathy	50	71.4	0.001(S)
Peripheral vascular disease	21	30.0	0.041(S)
Smoking	28	40.0	0.027(S)
Poor glycaemic control (HbA1c >8%)	52	74.3	0.0001(S)
Previous foot ulcer	18	25.7	0.049(S)

The majority of patients belonged to the 51-60 years age group accounting for 24 patients (34.3%), followed by the 41-50 years age group comprising 16 patients (22.9%). Patients aged 61-70 years constituted 21.4% of

the study population. Only 8 patients (11.4%) were below 40 years of age, while 7 patients (10.0%) were older than 70 years. The association between advancing age and occurrence of diabetic foot ulcer was found to be statistically significant (p=0.032) (Table 2).

Table 7: Microbiological profile.

Organisms isolated	Number of patients (N)	Percentage (%)	P value
Staphylococcus aureus	24	34.3	0.021(S)
Pseudomonas aeruginosa	16	22.9	
Klebsiella species	12	17.1	
Escherichia coli	10	14.3	
Mixed growth	8	11.4	
Total	70	100	

Table 8: Treatment modalities.

Treatment modality	Number of patients (N)	Percentage (%)	P value
Conservative management	27	38.6	0.003(S)
Debridement	30	42.9	
Incision and drainage	8	11.4	
Skin grafting	5	7.1	
Minor amputation	12	17.1	
Major amputation	8	11.4	
Total	70	100	

Out of 70 patients, 48 (68.6%) were males and 22 (31.4%) were females, demonstrating clear male predominance. Statistical analysis revealed significant association between male gender and diabetic foot ulcer occurrence (p=0.018) (Table 3).

Most patients had diabetes mellitus for prolonged duration. Twenty-four patients (34.3%) had diabetes for 5-10 years, while 20 patients (28.6%) had diabetes for 11-15 years. Sixteen patients (22.9%) had diabetes duration greater than 15 years. Long-standing diabetes mellitus significantly increases the risk of diabetic foot ulcer development due to chronic neuropathy, vasculopathy, and impaired immunity. The relationship between longer duration of diabetes and diabetic foot ulcer formation was statistically significant (p=0.006). (Table 4) Wagner grade II ulcers were most common and accounted for 24 patients (34.3%), followed by grade III ulcers in 20 patients (28.6%). Grade IV and grade V ulcers together constituted 20% of total cases, indicating advanced disease at presentation. Statistical analysis demonstrated a highly significant association between higher Wagner grades and poor clinical outcomes (p=0.001) (Table 5). Peripheral neuropathy was present in 50 patients (71.4%) and poor glycaemic control was observed in 52 patients (74.3%). Smoking history was identified in 28 patients (40%), while peripheral vascular disease was present in 21 patients (30%). Poor glycaemic control and peripheral neuropathy showed highly significant association with diabetic foot ulcer severity (p<0.001) (Table 6). Staphylococcus aureus was the most commonly isolated pathogen accounting for 34.3% of infections, followed by Pseudomonas aeruginosa in 22.9% of cases. Mixed bacterial infections were observed in 11.4% patients. The microbiological distribution showed statistically significant association with ulcer severity and wound infection (p=0.021) (Table 7).

Debridement was the most commonly performed procedure and was required in 42.9% of patients. Conservative treatment was sufficient in 38.6% of cases. Minor amputations were performed in 17.1% patients, whereas major amputations were required in 11.4%. The association between advanced ulcer grades and need for surgical intervention was statistically significant (p=0.003) (Table 8).

Table 9: Outcome according to Wagner grade.

Wagner grades	Complete healing N (%)	Minor amputation N (%)	Major amputation N (%)	P value
Grade I	12 (100)	0	0	<0.001(S)
Grade II	22 (91.7)	2 (8.3)	0	
Grade III	14 (70.0)	4 (20.0)	2 (10.0)	
Grade IV	3 (30.0)	4 (40.0)	3 (30.0)	
Grade V	0	1 (25.0)	3 (75.0)	
Total	—	—	—	

All Wagner grade I ulcers healed completely. Healing rates progressively declined with increasing Wagner grade. Grade III ulcers showed increased rates of minor and major amputations, while grade IV and V ulcers demonstrated significantly poorer outcomes. Major amputations were predominantly observed in grade IV and grade V ulcers. Statistical analysis revealed a highly significant association between increasing Wagner grade and amputation rates (p<0.001) (Table 9).

DISCUSSION

DFU is one of the leading causes of hospitalization among diabetic patients and represents a major cause of non-traumatic lower limb amputation worldwide.[15] The present study evaluated the clinical profile, management, and outcomes of diabetic foot ulcers according to Wagner's classification among 70 patients admitted to a

tertiary care hospital in Northern India. The majority of patients in the present study belonged to the age group of 51-60 years with male predominance. Similar findings have been reported in previous Indian studies where middle-aged and elderly males constituted the majority of diabetic foot patients.16,17 Increased outdoor activity, occupational trauma, smoking, and poor foot care practices among males may explain this predominance.

Wagner Grade II ulcers were the most common ulcers encountered in the present study. This finding is consistent with studies conducted by Shahi et al and Rastogi et al where deep ulcers involving tendon and subcutaneous tissue were commonly observed at the time of presentation.[7,18] Delayed healthcare seeking behaviour and lack of awareness regarding foot care contribute significantly to advanced ulcer grades in Indian populations.

Peripheral neuropathy was present in 71.4% of patients and emerged as the most important predisposing factor. Neuropathy causes loss of protective sensation, altered gait mechanics, dry skin, and increased plantar pressure leading to ulcer formation.[19] Poor glycaemic control observed in the majority of patients further impaired wound healing and increased susceptibility to infection.

Infection remains a major determinant of morbidity in diabetic foot ulcers. Deep tissue infection and osteomyelitis were commonly associated with Wagner grade III and IV ulcers. Prompt initiation of antibiotics combined with surgical debridement is crucial for infection control and limb preservation.[20,21] Surgical intervention was required in more than half of the patients in the present study. Debridement was the most commonly performed procedure, emphasizing the importance of removal of necrotic tissue and reduction of bacterial load for promoting healing. Minor and major amputations were predominantly associated with Wagner grade IV and V ulcers. Similar observations have been documented in earlier Indian and international studies.[22]

A significant association was observed between higher Wagner grades and increased amputation rates. Wagner grade V ulcers demonstrated the poorest outcomes with high rates of major amputation. These findings reaffirm the prognostic significance of Wagner's classification in predicting treatment outcomes and guiding management strategies.[23] Early diagnosis, patient education, strict glycaemic control, regular foot examination, smoking cessation, and multidisciplinary diabetic foot care programs can substantially reduce morbidity and amputation rates.[24] Recent advances including negative pressure wound therapy, growth factor therapy, and revascularization procedures have shown promising results in selected patients.[25]

Clinical implications

The present study highlights the importance of early diagnosis and prompt management of diabetic foot ulcers to prevent severe complications and limb loss. Wagner's classification proved to be a simple and effective tool for assessing ulcer severity, guiding treatment decisions, and predicting prognosis. Early-stage ulcers responded well to conservative treatment and debridement, whereas advanced Wagner grades were associated with increased infection, prolonged hospitalization, and higher amputation rates.

The study emphasizes the need for regular foot examination, strict glycaemic control, patient education, early infection management, and multidisciplinary care to reduce morbidity and improve limb salvage rates in diabetic patients.

CONCLUSION

DFU remains a major complication of diabetes mellitus associated with considerable morbidity, prolonged hospitalization, and risk of lower limb amputation. Wagner's classification provides a simple, practical, and reliable method for evaluating ulcer severity and planning management. Early diagnosis, aggressive infection management, strict glycaemic control, regular wound care, and timely surgical intervention play a crucial role in improving healing outcomes and reducing amputation rates. Advanced Wagner grades are significantly associated with poor prognosis and increased need for major amputations. Implementation of structured diabetic foot care programs, patient education initiatives, and multidisciplinary management approaches are essential for reducing the burden of diabetic foot disease in India.

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REFERENCES

1. International Diabetes Federation. IDF Diabetes Atlas. 10th ed. Brussels: IDF; 2021.
2. Sun H, Saeedi P, Karuranga S, Pinkepank M, Ogurtsova K, Duncan BB, et al. IDF Diabetes Atlas: Global, regional and country-level diabetes prevalence estimates for 2021 and projections for 2045. Diabetes Res Clin Pract. 2022;183:109-19.
3. Armstrong DG, Boulton AJM, Bus SA. Diabetic foot ulcers and their recurrence. N Engl J Med. 2017;376(24):2367-75.
4. Zhang P, Lu J, Jing Y, Tang S, Zhu D, Bi Y. Global epidemiology of diabetic foot ulceration: a systematic review and meta-analysis. Ann Med. 2017;49(2):106-16.
5. Boulton AJM. The pathway to foot ulceration in diabetes. Med Clin North Am. 2013;97(5):775-90.
6. Jeffcoate WJ, Harding KG. Diabetic foot ulcers. Lancet. 2003;361(9368):1545-51.
7. Shahi SK, Kumar A, Kumar S, Singh SK, Gupta SK, Singh TB. Prevalence of diabetic foot ulcer and

associated risk factors in diabetic patients from North India. J Diabet Foot Complications. 2012;4(3):83-91.
8. Pendsey SP. Understanding diabetic foot. Int J Diabetes Dev Ctries. 2010;30(2):75-9.
9. Mishra SC, Chhatbar KC, Kashikar A, Mehndiratta A. Diabetic foot. BMJ. 2017;359:j5064.
10. Wagner FW. The diabetic foot. Orthopedics. 1987;10(1):163-72.
11. Oyibo SO, Jude EB, Tarawneh I, Nguyen HC, Harkless LB, Boulton AJM. A comparison of two diabetic foot ulcer classification systems: the Wagner and the University of Texas wound classification systems. Diabetes Care. 2001;24(1):84-8.
12. Alexiadou K, Doupis J. Management of diabetic foot ulcers. Diabetes Ther. 2012;3(1):4.
13. Lipsky BA, Senneville E, Abbas ZG, Lips DMJ, Lipsky MA, Lavery LA, et al. Guidelines on the diagnosis and treatment of foot infection in persons with diabetes. Diabetes Metab Res Rev. 2020;36(S1):e3280.
14. Bus SA, Armstrong DG, Gooday C, Cavanagh NJ, van Netten ALK, Cavanagh PR, et al. Guidelines on offloading foot ulcers in persons with diabetes. Diabetes Metab Res Rev. 2020;36(S1):e3274.
15. Rastogi A, Goyal G, Kesavan R, Gupta SK, Kumar A, Singh SK, et al. Long-term outcomes after diabetic foot ulcer. Diabetes Res Clin Pract. 2020;162:108113.
16. Viswanathan V, Madhavan S, Rajasekar S, Gokulakrishnan R, Unnikrishnan RR, Ramachandran A. Amputation prevention initiative in South India. Diabetes Care. 2005;28(5):1019-21.
17. Seth A, Attri AK, Kataria H, Kumar R, Singh S, Sharma M, et al. Clinical profile and outcome of diabetic foot infections. Int Surg J. 2019;6(3):813-8.
18. Jain AKC, Vishwanath S. Diabetic foot complications and management in India. Int J Low Extrem Wounds. 2016;15(2):108-15.
19. Bowering CK. Diabetic foot ulcers: pathophysiology and prevention. Can Fam Physician. 2001;47:1007-16.
20. Lavery LA, Armstrong DG, Wunderlich RP, Tredwell MG, Boulton P, Boulton AJM. Risk factors for foot infections in diabetes. Diabetes Care. 2006;29(6):1288-93.
21. Prompers L, Huijberts M, Apelqvist J, Schaper NEH, Jeffcoate WJ, Armstrong DG, et al. High prevalence of ischemia in infected diabetic foot ulcers. Diabetologia. 2007;50(1):18-25.
22. Abbas ZG, Lutale JK, Morbach S, Archibald LK. Clinical outcome of diabetic patients hospitalized with foot ulcers. Diabet Med. 2002;19(7):575-9.
23. Monteiro-Soares M, Boyko EJ, Ribeiro J, Rasmussen A, Van Asten MG, Boulton AJM, et al. Predictive factors for diabetic foot ulcer outcomes. Diabetes Metab Res Rev. 2020;36(S1):e3275.
24. Singh N, Armstrong DG, Lipsky BA. Preventing foot ulcers in patients with diabetes. JAMA. 2005;293(2):217-28.
25. Everett E, Mathioudakis N. Update on management of diabetic foot ulcers. Ann N Y Acad Sci. 2018;1411(1):153-65.

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