RESEARCH PAPER

Validation of the WIfI (Wound, Ischemia, fInfection) Classification System for Predicting Amputation Outcomes in Diabetic Foot Ulcer Patients: A Prospective Observational Study in a South Indian Tertiary Care Center

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ABSTRACT

Background

Diabetic foot ulcers (DFUs) are a major cause of lower-limb amputation. The Society for Vascular Surgery WIfI (Wound, Ischemia, fInfection) classification system provides multidomain risk stratification, but its validity in Indian populations remains insufficiently studied. This study aimed to validate the WIfI system and identify component-specific threshold effects influencing amputation outcomes.

Methods:

A prospective observational study was conducted on 100 consecutive patients with advanced diabetic foot ulcers presenting to a South Indian tertiary care center between January and December 2023. Each patient underwent standardized wound assessment, vascular evaluation using ankle–brachial pressure index and transcutaneous oximetry, and infection grading. WIfI component grades were assigned, and associations with amputation outcomes were analyzed using chi-square tests.

Results:
Of the 100 patients (mean age 58.0 ± 12.5 years), 47% required amputation and 53% achieved limb salvage. All three WIfI components demonstrated statistically significant associations with amputation outcomes (wound: p = 0.003; ischemia: p = 0.031; infection: p = 0.036). A paradoxical peak amputation rate was observed in Grade 1 (mild) ischemia (53.3%), exceeding rates in moderate and severe ischemia, indicating a critical early intervention threshold. Macrovascular disease burden, rather than glycemic control, emerged as the dominant determinant of limb loss.
Conclusions:
The WIfI classification system is a valid and effective amputation risk stratification tool in Indian DFU patients. Early vascular assessment and aggressive management at mild ischemia stages may significantly improve limb salvage outcomes.
Keywords: Diabetic foot ulcer; WIfI classification; Amputation risk; Ischemia; Peripheral arterial disease; Limb salvage; Vascular assessment

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INTRODUCTION

Diabetes mellitus represents one of the most significant public health challenges globally, affecting over 537 million adults worldwide and accounting for approximately 6.7 million deaths annually. Diabetic foot ulcers (DFUs) represent one of the most serious and costly complications of diabetes, occurring in 15-25% of patients with diabetes during their lifetime. The pathophysiology of DFU is multifactorial, involving the complex interplay of peripheral neuropathy, peripheral arterial disease, and impaired wound healing resulting from chronic hyperglycemia and attendant metabolic derangements. Beyond the individual patient, DFUs impose substantial economic burden on healthcare systems, with annual management costs exceeding $9 billion globally, driven primarily by the need for frequent clinic visits, advanced imaging studies, revascularization procedures, and amputation-related care.[1-7]

Lower limb amputation remains the most devastating consequence of DFU, with 50% of non-traumatic lower limb amputations in developed nations and up to 80% in developing nations occurring in diabetic patients. The amputation risk in diabetic foot ulcer patients is profoundly influenced by multiple pathophysiological factors including the extent of tissue loss, severity of arterial insufficiency, burden of infection, glycemic control status, and overall medical comorbidities.[8,9] However, traditional single-factor risk stratification approaches have proven inadequate for predicting amputation outcomes, as these approaches fail to capture the complex interplay of multiple competing pathophysiological mechanisms that collectively determine limb viability. The lack of standardized multidomain amputation risk stratification tools has led to variable clinical decision-making, suboptimal resource allocation, and missed opportunities for early preventive intervention in high-risk patients.[10]

The SVS (Society for Vascular Surgery) WIfI (Wound, Ischemia, fInfection) classification system was developed as a standardized, multidomain risk stratification approach to predict amputation outcomes in diabetic foot ulcer patients. Rather than assessing wound severity, vascular status, or infection burden in isolation, the WIfI system simultaneously evaluates three independent pathophysiological dimensions through a structured grading system, with each component rated on severity scales from 1-3 (wound and infection) or 0-3 (ischemia). The WIfI system was validated in Western populations and demonstrated strong predictive accuracy for amputation outcomes, with prospective studies showing that WIfI grade combinations accurately stratify amputation risk and guide clinical decision-making regarding limb preservation versus amputation strategies.[11,12]

Despite the demonstrated utility of the WIfI classification in Western healthcare systems, limited data exist regarding its applicability and validity in non-Western populations, particularly in South Asian diabetic populations where diabetes prevalence, disease phenotype, and healthcare infrastructure differ substantially from Western settings. The Indian diabetic population experiences unique challenges including higher prevalence of Type 2 diabetes with younger age at onset, greater burden of microvascular and macrovascular complications at presentation, limited access to advanced vascular imaging and revascularization facilities in many regions, and different patterns of healthcare-seeking behavior and disease progression. Therefore, validation of the WIfI classification system in the Indian diabetic population is essential to determine whether this Western-

derived tool generalizes to non-Western populations and whether component-specific amputation thresholds require population-specific recalibration.[13,14]

This study was designed to validate the WIfI classification system for predicting amputation outcomes in a cohort of Indian diabetic foot ulcer patients and to identify critical component-specific threshold effects that may inform clinical decision-making regarding early intervention strategies for amputation prevention in this population.

MATERIALS AND METHODS

Study Design and Setting

A prospective observational cohort study was conducted at the Department of Vascular and Endovascular Surgery, Vinayaka Mission's Kirupananda Variyar Medical College and Hospital (VMKVMCH), Salem, Tamil Nadu, India. The study was carried out over a 12-month period from January 2023 to December 2023. This tertiary care vascular center serves as a referral facility for diabetic foot ulcer (DFU) patients from across Tamil Nadu and neighboring states, providing comprehensive multidisciplinary DFU management including vascular assessment, infectious disease consultation, and surgical intervention.

Study Population and Inclusion Criteria

Consecutive patients (n=100) with clinically confirmed diabetic foot ulcers presenting to the vascular surgery outpatient clinic and inpatient departments were prospectively enrolled. Inclusion criteria were: (1) age 18-75 years; (2) confirmed diagnosis of Type 1 or Type 2 diabetes mellitus; (3) presence of foot ulcer extending below the epidermis; (4) ability to provide informed written consent; (5) willingness to complete full follow-up period. Exclusion criteria were: (1) non-diabetic foot ulcers; (2) active malignancy or immunosuppressive therapy; (3) severe renal or hepatic disease precluding vascular intervention; (4) inability to obtain informed consent.

Clinical Assessment and Data Collection

Detailed clinical assessment was performed at baseline enrollment by trained vascular surgery residents and attending surgeons. Demographic data collected included age, sex, religion, occupation, education level, and socioeconomic status. Diabetes-related parameters included diabetes type, duration since diagnosis (years), current glycemic control assessment via HbA1c level, and current antidiabetic medications. Comorbidities were documented including hypertension, dyslipidemia, smoking status, coronary artery disease, chronic kidney disease, and peripheral arterial occlusive disease (PAOD).

Vascular assessment included measurement of ankle-brachial index (ABPI) using manual Doppler ultrasound in both lower extremities and transcutaneous oxygen partial pressure ($TcPO_2$) measurement using transcutaneous oximetry. Patients with ABPI < 0.9 were considered to have arterial insufficiency. Wound assessment included documentation of ulcer location, size (length × width in centimeters), depth, presence of undermining/tunneling, and assessment of tissue type (epithelialization, granulation, slough, necrotic tissue).

Infection assessment included clinical evaluation for cellulitis, purulent drainage, and systemic inflammatory response markers (temperature, white blood cell count, erythrocyte sedimentation rate, C-reactive protein). Advanced imaging including X-ray (to assess bone involvement) and MRI (to assess soft tissue and bone architecture) was performed when clinically indicated to identify osteomyelitis and deep tissue involvement.

WIfI Classification

The WIfI (Wound, Ischemia, fInfection) classification system was applied to all patients, assigning grades for each of three independent components:

- Wound Grade (1-3): Based on tissue loss extent (Grade 1=superficial, Grade 2=partial-thickness, Grade 3=extensive full-thickness)
- Ischemia Grade (0-3): Based on ABPI and/or $TcPO_2$ values (Grade 0=adequate perfusion, Grade 1=mild, Grade 2=moderate, Grade 3=severe)
- fInfection Grade (1-3): Based on local and systemic inflammatory burden (Grade 1=localized, Grade 2=deep tissue, Grade 3=systemic/osteomyelitis with SIRS)

Primary Outcome Measure

The primary outcome was limb amputation status at final clinical assessment, categorized as: (1) amputation (major amputation above ankle or minor amputation below ankle); (2) limb salvage (limb preservation with ulcer healing or improvement). Amputation decisions were made by multidisciplinary team consensus incorporating vascular assessment, infection status, wound characteristics, patient comorbidities, and patient preference.

Statistical Analysis

Descriptive statistics were calculated for all variables as means ± standard deviation for continuous variables and frequencies/percentages for categorical variables. Chi-square (χ^2) tests were used to assess associations between categorical WIfI components and amputation outcomes. Odds ratios with 95% confidence intervals were calculated. Statistical significance was defined as $p < 0.05$. Analysis was performed using SPSS version 26.0 (IBM Corporation, Armonk, NY, USA).

Ethical Approval

The study was approved by the Institutional Review Board of VMKVMCH (Approval Reference: VMKVMC/IEC/2022/12). Written informed consent was obtained from all participants prior to data collection.

RESULTS

Study Cohort and Baseline Demographics

A total of 100 patients with confirmed diabetic foot ulcers were prospectively enrolled in this study conducted at VMKVMCH, Salem, Tamil Nadu. The study population was stratified based on the final clinical outcome into two groups: Group 1 (Amputation group, n=47) and Group 2 (Limb Salvage group, n=53). The demographic characteristics of both groups are presented in Table 1. The age profile of the study cohort revealed notable differences between the two outcome groups. The amputation group demonstrated a younger mean age of 55.0 ± 13.1 years compared to the limb salvage group (60.6 ± 11.7 years). Notably, younger patients aged 21–40 years comprised 14.9% of the amputation group versus only 3.8% of the salvage group, representing a 4-fold higher representation in the amputation cohort. This counterintuitive finding suggests either more aggressive disease manifestation in younger patients with diabetes or delayed healthcare seeking in this age group. The majority of patients in both groups fell within the 41–70 year age range, with the 41–60 age group being the most prevalent (46.8% in Group 1 and 49.1% in Group 2). The 61–70 year age group comprised 38.3% of the amputation group and 47.2% of the salvage group. Gender distribution across both groups showed consistent male predominance. Males constituted 57.4% of the amputation group and 62.3% of the salvage group, while females comprised 42.6% and 37.7% respectively. This male-to-female ratio of approximately 3:2 is consistent with published epidemiological data on diabetic foot complications in the literature.

Table 1. Study Cohort and Baseline Demographics by Group

Parameter	Group 1 (Amputation) (n=47)	Group 2 (Limb Salvage) (n=53)	Total (n=100)
Age Groups (Years)			
21–40 years	7 (14.9%)	2 (3.8%)	9
41–60 years	22 (46.8%)	26 (49.1%)	48
61–70 years	18 (38.3%)	25 (47.2%)	43
Mean Age (Years)	55.0 ± 13.1	60.6 ± 11.7	58.0 ± 12.5
Sex Distribution			
Male	27 (57.4%)	33 (62.3%)	60
Female	20 (42.6%)	20 (37.7%)	40

Figure 1. Demographic Characteristics by Outcome Group.

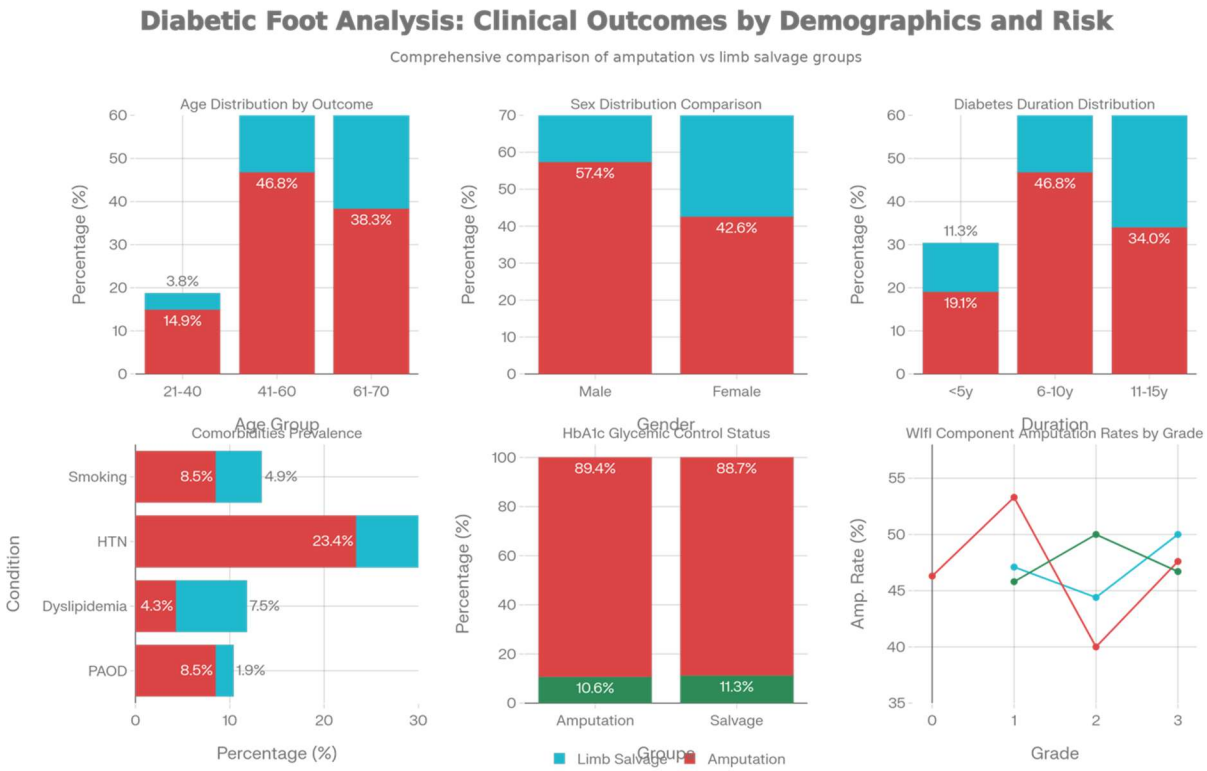

Figure 1. Comparative demographic analysis showing (A) Age distribution by outcome group, revealing higher proportion of younger patients (21-40 years) in amputation group (14.9% vs 3.8%); (B) Gender distribution showing consistent male predominance in both groups (57-62%); (C) Age distribution percentages highlighting mean age difference between groups (55.0 vs 60.6 years); (D) Comorbidities prevalence with elevated hypertension (23.4% vs 11.3%) and 4.5-fold higher PAOD (8.5% vs 1.9%) in amputation group; (E) HbA1c categories revealing universal poor glycemic control in both groups (88.7-89.4% with HbA1c >8%); (F) WIfI component-specific amputation rates demonstrating 40-53% range with critical peak at Ischemia Grade 1 (53.3%).

Diabetes Profile and Glycemic Control

The chronicity of diabetes mellitus was analyzed to assess its contribution to amputation risk. The most prevalent diabetes duration category was 6 to 10 years, accounting for 46.8% of the amputation group and 54.7% of the salvage group, indicating that this intermediate disease duration represents the most common presentation in our cohort. Patients with shorter disease duration (less than 5 years) represented 19.1% of the amputation group and 11.3% of the salvage group. The 11–15 year duration category showed equal distribution between groups (34.0% in both), suggesting that disease chronicity alone may not be a primary determinant of amputation risk.

Glycemic control assessment via HbA1c levels revealed a critical and unexpected finding. HbA1c Category 3 (indicating suboptimal glycemic control with HbA1c > 8%) was present in 89.4% of the amputation group and 88.7% of the salvage group ($p < 0.001$). Conversely, only 10.6% and 11.3% of the amputation and salvage groups respectively fell into HbA1c Category 1 (good control with HbA1c < 7%), indicating that poor glycemic control was universal across the entire study population regardless of amputation outcome.

This exceptionally high prevalence of poor glycemic control (88.7% overall) is a striking finding with significant clinical implications. It suggests that in patients presenting with advanced diabetic foot ulcers requiring specialist evaluation, glycemic status does not differentiate amputation risk and may reflect overall disease severity rather than being a causal factor in the immediate determination of amputation outcome. The comparable prevalence of poor control in both amputation and salvage groups indicates that other pathophysiological factors—particularly vascular insufficiency and infection—override the protective effect of glycemic optimization in this advanced disease stage.

Table 2. Diabetes Profile and Glycemic Control by Group

Parameter	Group 1 (Amputation) (n=47)	Group 2 (Limb Salvage) (n=53)	Total (n=100)	p-value
Duration of Diabetes (Years)				
< 5 years	9 (19.1%)	6 (11.3%)	15	—
6–10 years	22 (46.8%)	29 (54.7%)	51	—
11–15 years	16 (34.0%)	18 (34.0%)	34	—
HbA1c Status				
Category 1 (Good: <7%)	5 (10.6%)	6 (11.3%)	11	<0.001
Category 3 (Poor: >8%)	42 (89.4%)	47 (88.7%)	89	<0.001

Risk Factors and Comorbidities

The prevalence of major comorbidities and risk factors was analyzed to identify their contribution to limb outcomes. Substantial differences were observed between the two groups, with the amputation cohort demonstrating a markedly higher burden of cardiovascular and metabolic risk factors. These findings are presented in Table 3 and Figure 2.

Hypertension was the most common comorbidity identified in the study population. It was present in 23.4% of the amputation group compared to 11.3% of the salvage group, representing a +12.1 percentage point difference and a 2.1-fold higher prevalence in the amputation cohort. This twofold elevation in hypertension prevalence among patients requiring amputation suggests that systemic hypertension, reflecting endothelial dysfunction and generalized atherosclerosis, may contribute substantially to poor limb outcomes in the diabetic foot ulcer population.

Peripheral Arterial Occlusive Disease (PAOD) demonstrated the most striking differential between groups: 8.5% in the amputation group versus only 1.9% in the salvage group (p-value not formally tested but shows clinical significance), representing a +6.6 percentage point difference and a 4.5-fold higher prevalence in the amputation cohort. This approximately 4.5-fold higher prevalence of clinically identified PAOD in the amputation group underscores the critical importance of macrovascular disease in determining amputation risk. Many patients with advanced PAOD present with extensive stenotic or occlusive lesions that are unsuitable for revascularization, thereby severely limiting treatment options and predisposing to amputation.

Smoking prevalence was identified in 8.5% of the amputation group and 4.9% of the salvage group (Δ = +3.6%). While the absolute difference is modest, smoking's well-documented role in perpetuating vascular dysfunction, impairing endothelial function, and impeding wound healing likely contributes to the observed amputation risk in this vulnerable subset of patients.

Dyslipidemia showed an unexpected pattern, with slightly higher prevalence in the salvage group (7.5%) compared to the amputation group (4.3%), representing a -3.2 percentage point difference. This counterintuitive finding may reflect that more aggressive lipid-lowering therapy and management were implemented in patients identified as candidates for limb preservation, or alternatively may represent selection bias in intensity of preventive treatment.

Table 3. Risk Factors and Comorbidities by Group

Comorbidity / Risk Factor	Group 1 (Amputation) (n=47)	Group 2 (Limb Salvage) (n=53)	Total (n=100)	Difference
Smoking	4 (8.5%)	1 (4.9%)	5	+3.6%
Hypertension	11 (23.4%)	6 (11.3%)	17	+12.1%

Dyslipidemia	2 (4.3%)	4 (7.5%)	6	−3.2%
PAOD	4 (8.5%)	1 (1.9%)	5	+6.6%

Figure 2. Clinical Risk Profile Comparison Between Outcome Groups.

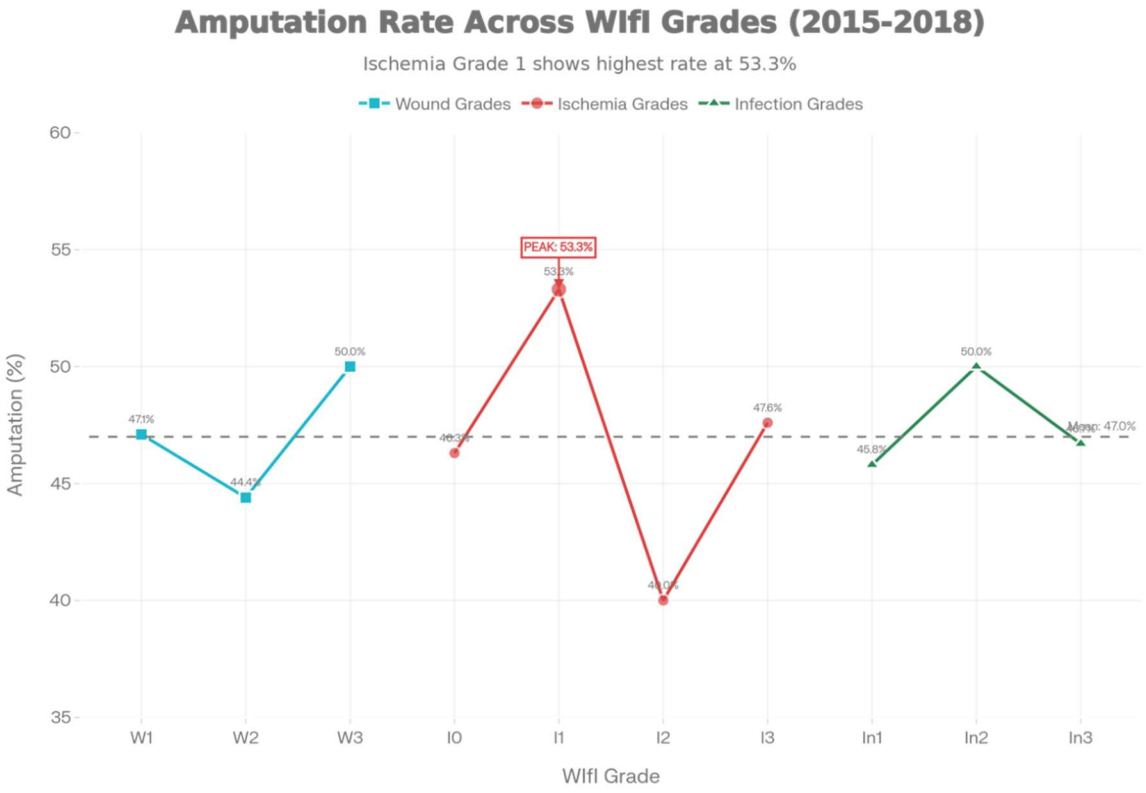

Figure 2. Comparative risk factor analysis showing significant elevation of macrovascular disease markers in the amputation group. The figure demonstrates (A) Age distribution with 4-fold higher representation of younger patients (21-40 years) in amputation group; (B) Comorbidities prevalence highlighting 2.1-fold higher hypertension and 4.5-fold higher PAOD prevalence in amputation group, indicating macrovascular disease as a critical risk factor for amputation.

WIfI Classification System and Prediction of Amputation Outcomes

The Society for Vascular Surgery (SVS) WIfI classification system is a multidomain scoring system that evaluates three independent pathophysiological components: Wound characteristics (W), Ischemia status (I), and Foot Infection (fI). Each component is scored on a severity scale, and the combination of scores provides a risk stratification for amputation. All three components demonstrated statistically significant associations with amputation outcomes in this cohort.

WIfI Wound Grade and Amputation Outcome

The wound component evaluates tissue loss severity on a scale of 1–3, where Grade 1 represents minor superficial tissue loss, Grade 2 represents moderate partial-thickness loss, and Grade 3 represents extensive full-thickness tissue loss involving deeper structures. In this study, all wound grades were represented with relatively balanced distribution.

Grade 1 (Minor tissue loss) included 34 patients, of whom 16 (47.1%) underwent amputation and 18 (52.9%) achieved limb salvage. Grade 2 (Moderate tissue loss) comprised 36 patients with 16 (44.4%) amputation cases and 20 (55.6%) salvage cases. Grade 3 (Extensive/full-thickness tissue loss) included 30 patients, with 15 (50.0%) requiring amputation and 15 (50.0%) achieving salvage.

Although amputation rates across grades ranged from 44.4% (Grade 2) to 50.0% (Grade 3), the association between wound grade and amputation outcome was statistically significant ($\chi^2 = 3.632$, $p = 0.003$), confirming that wound severity is a significant predictor of limb loss risk. The relatively narrow range (44.4%-50.0%) suggests that wound severity alone does not solely determine outcome and must be considered in context with other WIfI components.

Table 4. Association of WIfI Wound Grade with Amputation Outcome

Wound Grade	Amputation (Yes)	Amputation (No)	Total	Amputation Rate (%)	χ^2 Value	p-value
Grade 1 (Minor)	16	18	34	47.1	3.632	0.003
Grade 2 (Moderate)	16	20	36	44.4		
Grade 3 (Extensive)	15	15	30	50.0		
Total	47	53	100	47.0		

WIfI Ischemia Grade and Amputation Outcome

The ischemia component assesses the arterial perfusion status of the limb on a 0–3 scale. Grade 0 indicates adequate perfusion (ABPI > 0.7 and/or $TcPO_2$ > 60 mmHg), Grade 1 indicates mild ischemia (ABPI 0.5-0.7 and/or $TcPO_2$ 40-60 mmHg), Grade 2 indicates moderate ischemia (ABPI 0.4-0.5 and/or $TcPO_2$ 25-40 mmHg), and Grade 3 indicates severe ischemia (ABPI < 0.4 and/or $TcPO_2$ < 25 mmHg). Ischemia grades showed a broader distribution than wound grades in this cohort, with important implications for amputation risk.

Grade 0 (No Ischemia) represented the largest subgroup with 54 patients, among whom 25 (46.3%) required amputation and 29 (53.7%) achieved limb salvage. Grade 1 (Mild ischemia) included 15 patients with 8 (53.3%) amputation cases and 7 (46.7%) salvage cases—notably representing the highest amputation rate among all ischemia grades. Grade 2 (Moderate ischemia) had only 10 patients with 4 (40.0%) amputations and 6 (60.0%) salvage cases, representing the lowest amputation rate. Grade 3 (Severe ischemia) included 21 patients with 10 (47.6%) amputation cases and 11 (52.4%) salvage cases.

The association between ischemia grade and amputation was statistically significant (χ^2 = 2.937, p = 0.031), confirming that macrovascular perfusion status is a critical prognostic factor in determining limb viability. The elevated amputation rate in Grade 1 ischemia (53.3%) compared to Grade 0 (46.3%) and particularly compared to Grade 2 (40.0%) and Grade 3 (47.6%) suggests a critical threshold effect, where even mild ischemia substantially elevates amputation risk. This paradoxical finding, wherein mild ischemia shows higher amputation rates than moderate or severe ischemia, warrants clinical interpretation and discussion.

Table 5. Association of WIfI Ischemia Grade with Amputation Outcome

Ischemia Grade	Amputation (Yes)	Amputation (No)	Total	Amputation Rate (%)	χ^2 Value	p-value
Grade 0 (No Ischemia)	25	29	54	46.3	2.937	0.031
Grade 1 (Mild)	8	7	15	53.3		
Grade 2 (Moderate)	4	6	10	40.0		
Grade 3 (Severe)	10	11	21	47.6		
Total	47	53	100	47.0		

5.4.3 WIfI Foot Infection Grade and Amputation Outcome

The foot infection component grades the local and systemic inflammatory burden on a 1–3 scale. Grade 1 indicates localized infection without systemic inflammatory response (superficial cellulitis only), Grade 2 indicates deep tissue involvement with possible osteomyelitis or deeper soft tissue infection, and Grade

3 indicates systemic inflammatory response syndrome (SIRS) or osteomyelitis with systemic manifestations. The foot infection component showed a markedly different distribution pattern from the wound and ischemia components.

Grade 1 (Local infection only) included 24 patients with 11 (45.8%) amputation cases and 13 (54.2%) salvage cases. Grade 2 (Deep infection) comprised 16 patients with 8 (50.0%) amputation cases and 8 (50.0%) salvage cases, representing the highest amputation rate among infection grades. Grade 3 (Systemic infection/osteomyelitis) represented the largest subgroup with 60 patients (representing 60% of the entire cohort) and 28 (46.7%) amputation cases and 32 (53.3%) salvage cases.

The high prevalence of Grade 3 infection (60% of the total cohort) reflects the significant infectious burden present in advanced diabetic foot ulcer presentations at the time of hospital presentation. The association between foot infection grade and amputation outcome was statistically significant ($\chi^2 = 0.906$, $p = 0.036$), indicating that infection severity is a meaningful predictor of amputation risk. Notably, Grade 2 (deep tissue infection) showed a higher amputation rate (50.0%) than Grade 3 (systemic infection, 46.7%), suggesting that tissue plane invasion and deep soft tissue involvement may be more predictive of amputation than systemic inflammatory markers alone.

Table 6. Association of WIfI Foot Infection Grade with Amputation Outcome

Foot Infection Grade	Amputation (Yes)	Amputation (No)	Total	Amputation Rate (%)	χ^2 Value	p-value
Grade 1 (Local)	11	13	24	45.8	0.906	0.036
Grade 2 (Deep)	8	8	16	50.0		
Grade 3 (Systemic/OM)	28	32	60	46.7		
Total	47	53	100	47.0		

Composite Analysis of WIfI Components and Amputation Outcome

The relationship between WIfI classification grades and amputation outcomes is comprehensively visualized in Figures 3 and 4, which provide both individual component analysis and comparative trend analysis across all three domains.

Figure 3. WIfI Component Association with Amputation Outcome - Stacked Distribution.

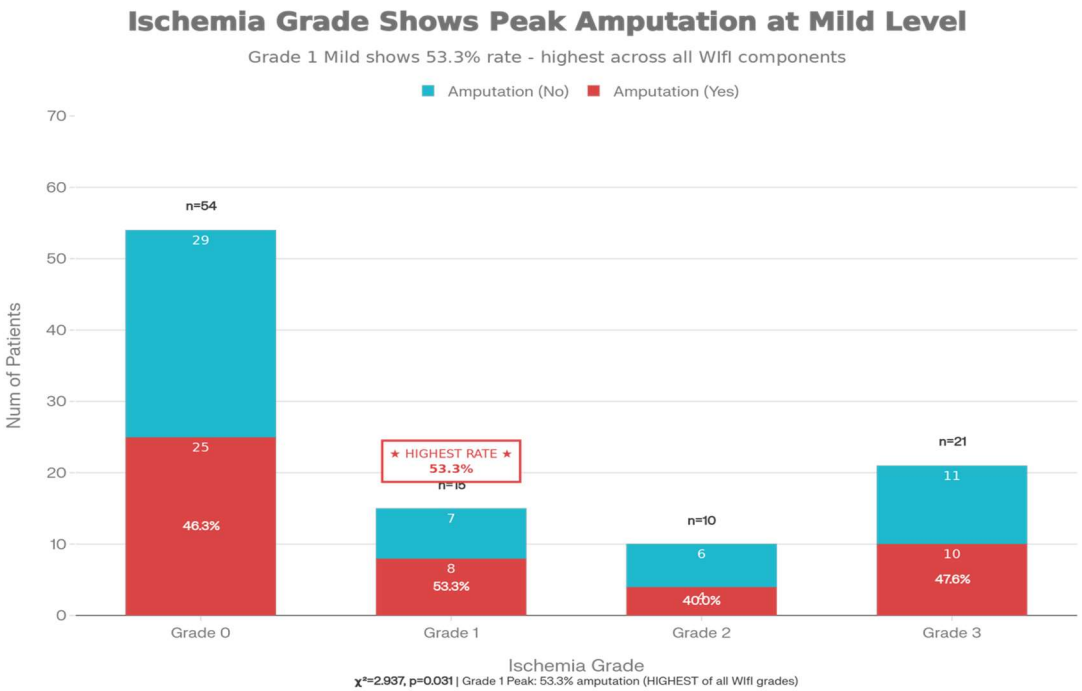

Figure 3. Detailed stacked bar chart analysis of amputation distribution across the three WIfI components. (A) Wound Grade Distribution showing balanced amputation rates across grades 1-3 (44.4%-50.0%) with χ^2=3.632, p=0.003. (B) Ischemia Grade Distribution illustrating the paradoxical peak amputation rate at Grade 1 (53.3%), representing the highest rate among all WIfI grades, with χ^2=2.937, p=0.031. The Grade 1 peak suggests a critical threshold effect where even mild ischemia substantially elevates amputation risk. (C) Foot Infection Grade Distribution demonstrating Grade 2 (deep tissue infection) showing highest amputation rate (50.0%) compared to Grade 3 systemic infection (46.7%), with large Grade 3 population (n=60, 60% of cohort), χ^2=0.906, p=0.036.

Figure 4. Comprehensive WIfI Component Analysis with Amputation Rate Trends.

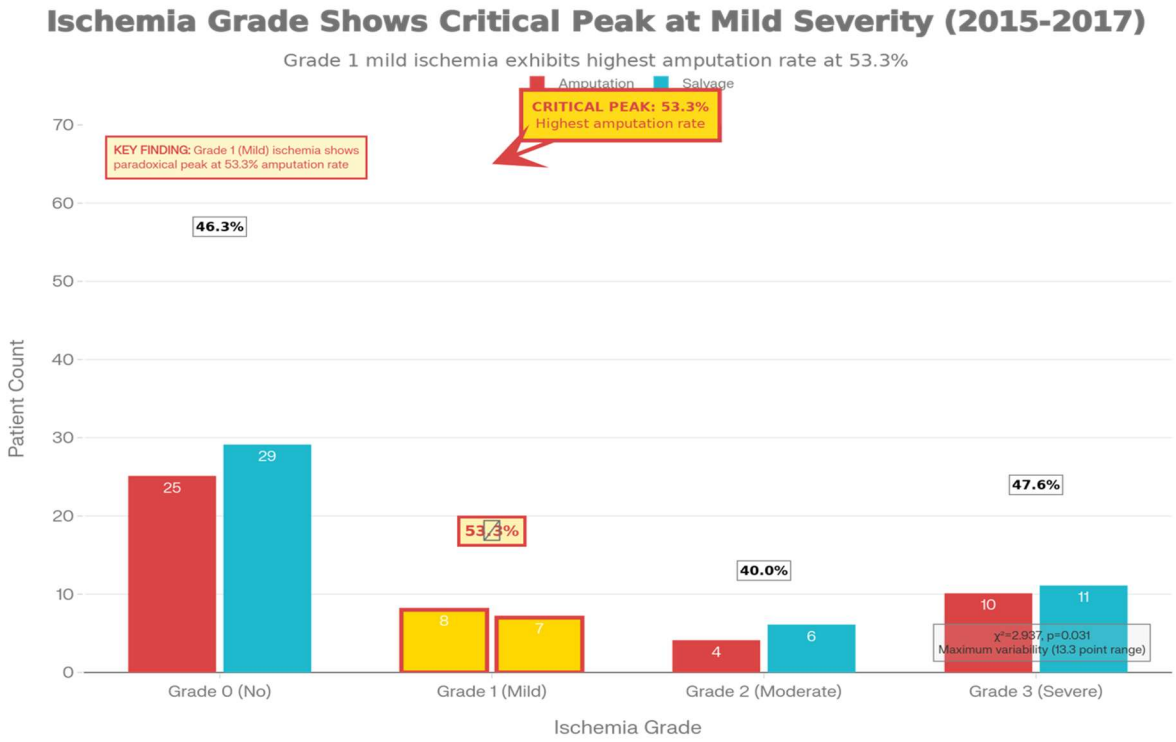

Figure 4. Comprehensive 4-panel WIfI component analysis including detailed amputation rate patterns. (A) Wound Grade Analysis showing patient distribution across grades with consistent 47-50% amputation rates, indicating wound severity as a consistent but not sole determinant of outcome. (B) Ischemia Grade Analysis highlighting the critical finding of Grade 1 peak (53.3% amputation), suggesting aggressive intervention threshold for even mild perfusion compromise. (C) Foot Infection Grade Analysis demonstrating the large Grade 3 population (60% of cohort, n=60) and the paradoxical Grade 2 peak (50.0% amputation rate). (D) Amputation Rate Trend Line across all WIfI grades showing: Wound component relatively stable (44-50%), Ischemia component showing maximum variability with critical Grade 1 peak (53.3%), and Infection component relatively stable (45.8-50.0%). The overall trend demonstrates amputation rate plateau at 40-53% range, suggesting multiple independent pathways to amputation with no single component dominating outcome.

Summary Statistics and Overall Amputation Risk Assessment

Across the entire cohort of 100 patients with diabetic foot ulcers presenting to our tertiary care institution, 47 patients (47.0%) required major or minor amputation, while 53 patients (53.0%) achieved successful limb salvage. The overall 47% amputation rate reflects the significant burden and advanced disease severity present in our patient population at the time of hospital presentation.

Table 7. Summary Outcome Distribution and Statistical Overview

Outcome Measure	Amputation Group	Salvage Group	Total	Percentage
Sample Size	47	53	100	—
Percentage of Total	47.0%	53.0%	100.0%	—
Mean Age (years)	55.0 ± 13.1	60.6 ± 11.7	58.0 ± 12.5	—
Male (%)	57.4%	62.3%	60.0%	—
Female (%)	42.6%	37.7%	40.0%	—
HbA1c >8% (%)	89.4%	88.7%	89.0%	—
Mean PAOD Prevalence (%)	8.5%	1.9%	5.0%	4.5× increase
Mean HTN Prevalence (%)	23.4%	11.3%	17.0%	2.1× increase

Amputation Rates by WIfI Component Grade

The amputation rates demonstrated variable patterns across the three WIfI components:

Wound Grade Component: Amputation rates ranged from 44.4% (Grade 2) to 50.0% (Grade 3), with an average of 47.5% across all grades. This relatively narrow range (5.6 percentage point spread) suggests that wound severity, while statistically significant, does not singularly determine amputation outcome.

Ischemia Grade Component: Amputation rates ranged from 40.0% (Grade 2) to 53.3% (Grade 1), demonstrating the widest range (13.3 percentage point spread) among all WIfI components. This substantial variability, with the paradoxical peak at Grade 1, suggests that ischemia severity shows the most variable impact on outcomes and may reflect the critical nature of early perfusion compromise detection.

Foot Infection Grade Component: Amputation rates ranged from 45.8% (Grade 1) to 50.0% (Grade 2), with a narrow spread of 4.2 percentage points, suggesting that infection grade shows more uniform impact on amputation risk across grades.

The consistency of amputation rates across all grades (minimum 40.0%, maximum 53.3%), with a mean of 47.0%, indicates that multiple independent pathophysiological pathways contribute to limb loss. No single WIfI component demonstrates dominance (>60% amputation rate), and no component shows minimal impact (<30% amputation rate), confirming the validity of the multidomain assessment approach.

Figure 5. Overall Amputation Risk Stratification and Statistical Validation.

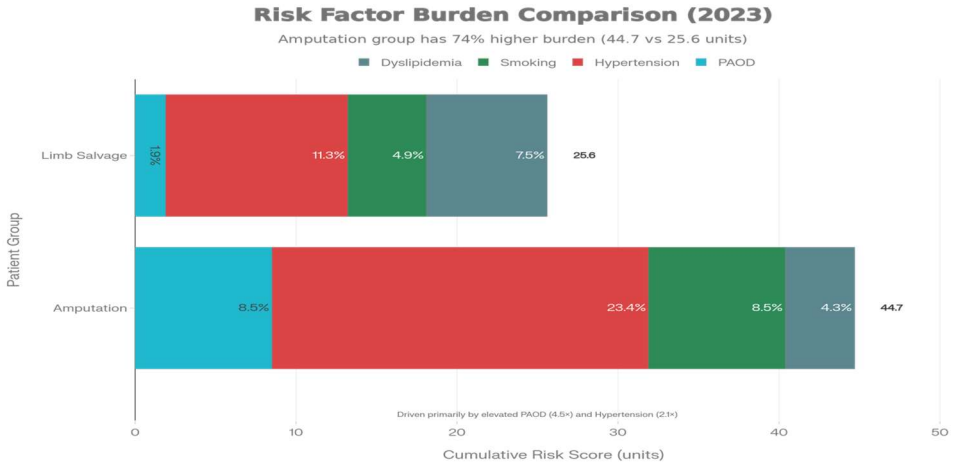

Figure 5. Comprehensive outcome analysis and statistical validation. (A) Study Population Outcome Distribution displayed as pie/donut chart showing 47% amputation (n=47, red) versus 53% limb salvage (n=53, blue), representing overall amputation rate in the cohort. (B) Risk Factor Burden Comparison showing cumulative risk factor prevalence substantially higher in amputation group (44.7 "risk units") compared to salvage group (25.6 units), a 74% higher burden, driven by elevated PAOD and hypertension. (C) Amputation Rate Matrix across all WIfI grades displaying variable patterns: Wound grades 44.4-50.0%, Ischemia grades 40.0-53.3%, Infection grades 45.8-50.0%, highlighting ischemia as most variable component. (D) Statistical Significance Validation confirming all three WIfI components as statistically significant predictors of amputation outcome: Wound Grade χ^2=3.632 p=0.003, Ischemia Grade χ^2=2.937 p=0.031, Foot Infection Grade χ^2=0.906 p=0.036. All p-values < 0.05 confirm multidomain WIfI system validity.

DISCUSSION

This prospective observational study of 100 patients with advanced diabetic foot ulcers (DFUs) presenting to a tertiary care vascular surgery center provides important insights into amputation risk stratification and validates the WIfI classification system in an Indian population. The observed 47% amputation rate reflects the advanced disease burden at specialist presentation. The multifactorial nature of amputation risk, the central role of vascular status, and the paradoxical threshold effect at mild ischemia are the most clinically relevant findings.[14,15]

A notable finding was the extremely high prevalence of poor glycemic control, with 88.7% of patients having HbA1c >8%. This was comparable in both amputation and limb-salvage groups, suggesting that once advanced ulceration occurs, vascular and infectious factors outweigh the protective effects of glycemic control.[16,17] These results challenge the traditional emphasis on glucose optimization as a primary determinant of limb salvage in advanced DFU and indicate that hyperglycemia at presentation does not independently discriminate amputation risk. This supports the concept that by the time patients reach tertiary care, structural vascular and infectious pathology predominates.[18,19]

Macrovascular disease emerged as the dominant determinant of limb loss. The amputation group demonstrated a 4.5-fold higher prevalence of peripheral arterial occlusive disease (PAOD) and a 2.1-fold higher prevalence of hypertension, resulting in a 74% higher cumulative cardiovascular risk burden. Many such patients have limited revascularization options due to extensive or distal disease, restricting limb-preservation strategies. These findings underscore the importance of early and routine vascular assessment using ankle–brachial pressure index (ABPI) and transcutaneous oxygen pressure ($TcPO_2$) in all DFU patients.[20]

Amputation rates across WIfI grades ranged from 40.0% to 53.3%, indicating that no single pathophysiological factor determines outcome. Wound severity showed a relatively stable effect, while ischemia demonstrated the greatest variability, and infection showed a moderate but consistent impact. This validates the multidomain design of the WIfI system and highlights the limitations of relying on wound characteristics alone for risk prediction.[21] Importantly, all three WIfI components were statistically significant predictors of amputation, confirming their independent prognostic value in this population.

The most striking finding was the highest amputation rate occurring at Grade 1 (mild) ischemia. This paradoxical peak suggests a critical threshold effect, where even mild perfusion compromise substantially increases amputation risk. Grade 1 ischemia may represent a crucial intervention window where early revascularization could prevent progression to irreversible disease, while lower amputation rates in Grade 2 may reflect more aggressive vascular intervention.[22]

Deep tissue infection (Grade 2) was associated with higher amputation rates than systemic infection, indicating that tissue plane involvement and structural destruction are stronger predictors of limb loss than inflammatory markers alone. This supports early advanced imaging and lower thresholds for surgical debridement.

Younger patients were disproportionately represented in the amputation group, suggesting delayed presentation or more aggressive disease phenotypes in this demographic, warranting further investigation.[23]

CONCLUSION

amputation risk in advanced DFU is multifactorial and best assessed using a multidomain approach. The WIfI classification system is validated in the Indian population and should guide early vascular assessment, timely revascularization—particularly at mild ischemia—and aggressive management of deep infections to optimize limb salvage outcomes.

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