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Clinicopathological Analysis and Management of Lower Limb Ulcers

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Abstract

Background: Lower limb ulcers represent a significant clinical challenge due to their chronicity, diverse etiology, and high morbidity. Despite advances in diagnostic and therapeutic modalities, management outcomes remain variable across patient populations.

Objectives: To study the clinicopathological profile of lower limb ulcers and evaluate their management outcomes in a tertiary care setting.

Methods: A prospective interventional study was conducted in the Department of General Surgery, SRM Medical College, Trichy, from July 2024 to June 2025. A total of 100 patients aged 18–65 years with lower limb ulcers were enrolled using convenience sampling. Detailed history, clinical examination, and relevant investigations were performed. Patients were assessed for associations with comorbidities (hypertension, diabetes, smoking), peripheral vascular status, neuropathy, and history of trauma. Management included surgical debridement, lumbar sympathectomy, or amputation as indicated. Data were analyzed and compared with existing literature.

Results: Venous ulcers were the most common etiology (40%), followed by diabetic ulcers (34%), arterial ulcers (17%), and traumatic ulcers (9%). Venous ulcers showed strong association with varicose veins (30%), while arterial ulcers were significantly associated with Raynaud's phenomenon (47%) and absent peripheral pulses (47%). Neuropathy-related sensory loss was most frequent in diabetic ulcers (35%). Hypertension was prevalent in arterial (71%) and venous (30%) ulcers, while smoking was common in arterial (88%) and diabetic ulcers (76%). Surgical debridement was most often required for diabetic (76%) and venous ulcers (38%). Lumbar sympathectomy was performed in 18% of arterial ulcer cases. Amputation was necessary in 44% of patients, particularly those with arterial (65%) and venous ulcers (78%).

Conclusions: Venous and diabetic ulcers constitute the majority of lower limb ulcers, with significant contributions from vascular and neuropathic mechanisms. Risk factors such as hypertension, diabetes, and smoking strongly influence disease course and outcomes. Surgical debridement and timely vascular interventions play a crucial role in management, while amputation remains a last resort in advanced cases. Early diagnosis, multidisciplinary care, and risk-factor modification are essential for improving limb salvage and reducing morbidity.

Keywords: Lower limb ulcer, venous ulcer, diabetic ulcer, arterial ulcer, neuropathy, amputation, debridement, sympathectomy

Introduction

An ulcer is a discontinuity in the epithelial surface associated with destruction of the underlying tissues, which may extend to involve subcutaneous fat, muscle, or even bone [1]. A chronic ulcer is generally defined as a full-thickness skin defect that does not heal or re-epithelialize within four weeks [2]. Such wounds display impaired healing not merely due to their depth or size, but because of underlying pathological processes that must be identified and corrected to achieve recovery [3].Lower limb and foot ulcers are common clinical problems with significant morbidity. They are frequently encountered in surgical wards and outpatient clinics, causing pain, disability, and financial burden [4]. Their etiology is

diverse, spanning medical, surgical, and dermatological domains. The leading causes include chronic venous insufficiency, peripheral arterial disease, and diabetes mellitus [5]. Less frequent causes are infections, vasculitis's, skin cancers, and inflammatory dermatoses such as pyoderma gangrenosum [6]. Rare associations, such as combined hypercoagulability and vasculitis syndromes, have also been described [7].

The incidence of leg ulcers is higher in the elderly, largely due to comorbidities such as atherosclerosis, diabetes, obesity, and smoking [8]. Despite extensive research in the last few decades on the anatomy, pathology, and treatment of chronic ulcers, management continues to evolve, and innovative strategies remain essential [9]. Vascular ulcers account for over 90% of chronic leg ulcers. Of these, venous hypertension contributes to approximately 70% of cases, mixed venous-arterial disease to 15%, and pure arterial insufficiency to about 5% [10]. The CEAP classification (Clinical, Etiological, Anatomical, Pathophysiological) provides a standardized framework for assessment and treatment of venous ulcers [11]. Arterial ulcers arise from impaired perfusion due to mechanisms such as vessel wall thickening, intraluminal obstruction, or external compression [12]. Diabetic foot ulcers constitute another major group, with nearly 15% of individuals with diabetes developing one during their lifetime [13]. They are multifactorial, with peripheral neuropathy being the most important cause. Loss of protective sensation leads to repetitive, unnoticed trauma, abnormal pressure distribution, and eventual skin breakdown. These ulcers are further complicated by infection and delayed healing [14].

Materials & Methods

Study Design

This prospective interventional study was conducted to evaluate the clinical profile, management strategies, and treatment outcomes of patients presenting with lower limb ulcers.

Study Setting and Duration

The study was carried out in the Department of General Surgery, SRM Medical College, Trichy, over a period of one year, from July 2024 to June 2025. Patients were recruited from both the General Surgery Outpatient Department (OPD) and the surgical inpatient wards.

Study Population

The study population comprised adult patients presenting with lower limb ulcers who attended the Department of General Surgery during the study period. Participants were selected using a convenience sampling technique after confirming eligibility according to the predefined inclusion and exclusion criteria.

Sample Size

A total of 100 patients with lower limb ulcers were enrolled in the study.

Inclusion Criteria

Patients aged 18 to 65 years with any type of lower limb ulcer who were willing to provide written informed consent were included in the study.

Exclusion Criteria

Patients who declined participation, individuals younger than 18 years or older than 65 years, immunocompromised patients including those with HIV infection, those receiving long-term corticosteroid therapy, individuals with other known immunodeficiency disorders, and patients with clinically suspected or histopathologically confirmed malignant ulcers were excluded from the study.

Data Collection Tool

Following approval from the Institutional Ethics Committee, eligible participants were enrolled after obtaining written informed consent. Baseline demographic characteristics and detailed clinical history were recorded using a structured case record proforma. Each patient underwent a comprehensive general physical examination and a detailed local examination of the ulcer. Ulcer characteristics including site, size, depth, duration, number of ulcers, wound bed characteristics, edge, floor, surrounding skin changes, discharge, presence of infection, vascular status, neurological assessment, and underlying etiology were documented systematically. Associated comorbid conditions such as diabetes mellitus, peripheral vascular disease, hypertension, chronic venous insufficiency, smoking history, and other relevant risk factors were also recorded. Appropriate laboratory investigations, including complete blood count, blood glucose estimation, renal function tests, wound culture and sensitivity, Doppler studies, radiological investigations, and other relevant diagnostic tests, were performed whenever clinically indicated. Patients subsequently received appropriate treatment according to the study protocol based on the etiology and severity of the ulcer. Treatment modalities included wound debridement, appropriate dressings, antibiotic therapy, glycemic control, compression therapy, vascular interventions, skin grafting, or other surgical procedures as required. Participants were followed at regular intervals, and treatment outcomes including ulcer healing, reduction in ulcer size, infection control, need for additional surgical intervention, complications, duration of hospital stay, and overall clinical outcome were documented systematically throughout the follow-up period.

Ethical Considerations

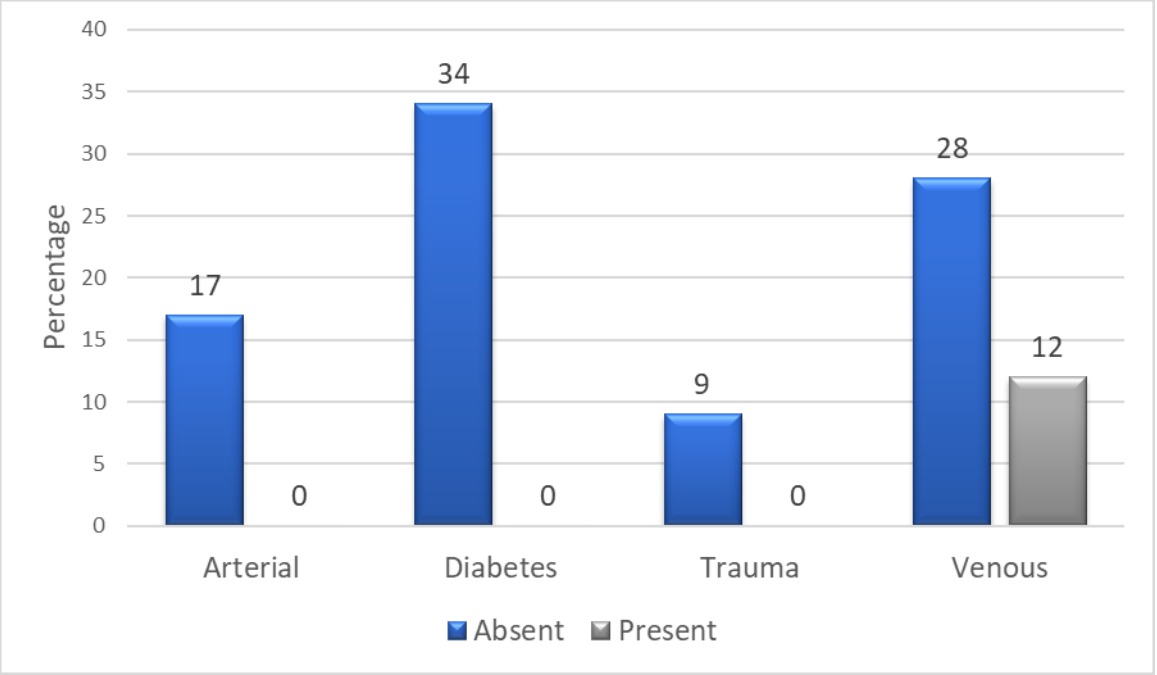
The study protocol was approved by the Institutional Ethics Committee before commencement of the study. Written informed consent was obtained from all participants after explaining the objectives and procedures of the study. Confidentiality of patient information was maintained throughout data collection, analysis, and reporting. Participation was voluntary, and all study procedures were conducted in accordance with the ethical principles of the Declaration of Helsinki and the Indian Council of Medical Research (ICMR) guidelines.

Statistical Analysis

Data were entered into Microsoft Excel 2019 and analyzed using IBM SPSS software version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD) or median with interquartile range (IQR) depending on data distribution, while categorical variables were presented as frequencies and percentages. Comparisons between groups were performed using the Chi-square test or Fisher's exact test for categorical variables and the Independent Student's t-test or Mann–Whitney U test for continuous variables, as appropriate. Paired Student's t-test or Wilcoxon signed-rank test was used to compare pre- and post-intervention parameters where applicable. Binary logistic regression analysis was performed to identify independent predictors of ulcer healing and treatment outcomes. A p-value <0.05 was considered statistically significant.

Results

Table 1. Association of Varicose Veins with Causes of Ulcers (N = 100)



Venous ulcers showed the strongest association with varicose veins (30%), whereas arterial, diabetic, and traumatic ulcers showed no direct association.

Table 1. Association of Raynaud's Phenomenon with Causes of Ulcers

Cause of Ulcer	Absent	Present	Total
Arterial	9	8	17
Diabetes	34	0	34
Trauma	9	0	9
Venous	40	0	40
Total	92	8	100

Arterial ulcers were the only group significantly associated with Raynaud's phenomenon (47%).

Table 2. Association of Loss of Sensation with Causes of Ulcers

Cause of Ulcer	Absent	Present	Total
Arterial	6	11	17
Diabetes	22	12	34
Trauma	9	0	9
Venous	31	9	40
Total	68	32	100

Neuropathy-related ulcers were most common in diabetes (35% with loss of sensation), followed by arterial ulcers (65% with sensory loss).

Table 3. Association of Peripheral Pulses with Causes of Ulcers

Cause of Ulcer	Absent	Present	Total
Arterial	8	9	17
Diabetes	0	34	34
Trauma	0	9	9
Venous	2	38	40
Total	10	90	100

Absence of peripheral pulses was strongly associated with arterial ulcers (47%). Pulses were generally preserved in diabetic, venous, and traumatic ulcers.

Table 4. Association of Hypertension with Causes of Ulcers

Cause of Ulcer	Absent	Present	Total
Arterial	5	12	17
Diabetes	20	14	34
Trauma	6	3	9
Venous	28	12	40
Total	59	41	100

Hypertension was most commonly observed among arterial (71%) and venous (30%) ulcer patients.

Table 5. Association of Diabetes Mellitus with Causes of Ulcers

Cause of Ulcer	Absent	Present	Total
Arterial	9	8	17
Diabetes	0	34	34
Trauma	9	0	9
Venous	22	18	40
Total	40	60	100

As expected, all diabetic ulcers were present in patients with diabetes. Interestingly, 45% of venous ulcers also co-existed with diabetes.

Table 6. Association of Smoking with Causes of Ulcers

Cause of Ulcer	Absent	Present	Total
Arterial	2	15	17
Diabetes	8	26	34
Trauma	3	6	9
Venous	20	20	40
Total	33	67	100

Smoking was a major risk factor, seen in 88% of arterial ulcers and 76% of diabetic ulcers.

Table 7. Surgical Debridement in Relation to Causes of Ulcers

Cause of Ulcer	Not Required	Required	Total
Arterial	14	3	17
Diabetes	8	26	34
Trauma	9	0	9
Venous	25	15	40
Total	56	44	100

Surgical debridement was most frequently required in diabetic (76%) and venous ulcers (38%).

Table 8. Lumbar Sympathectomy in Relation to Causes of Ulcers

Cause of Ulcer	Not Done	Done	Total
Arterial	14	3	17
Diabetes	34	0	34
Trauma	9	0	9
Venous	40	0	40
Total	97	3	100

Lumbar sympathectomy was selectively performed in arterial ulcers (18%).

Table 9. Amputation in Relation to Causes of Ulcers

Cause of Ulcer	Not Required	Required	Total
Arterial	6	11	17
Diabetes	32	2	34
Trauma	9	0	9
Venous	9	31	40
Total	56	44	100

Amputation was most frequently required for arterial ulcers (65%) and venous ulcers (78%), while rare in diabetic ulcers (6%).

Discussion

In this prospective interventional study of 100 patients with lower-limb ulcers, venous ulcers were the most common cause (40%), followed by diabetic ulcers (34%), arterial ulcers (17%), and traumatic ulcers (9%). Our findings both support and diverge from earlier reports. Abbade and Lastória reported that venous ulcers account for nearly 70% of all lower limb ulcers in population-based studies, which is higher than the 40% observed in our series [15]. Similarly, Vasudevan highlighted that venous pathology remains the predominant cause of chronic lower limb ulcers in India [16]. The lower proportion of venous ulcers in our cohort may be due to referral bias, as our hospital-based surgical department more often receives complicated arterial and diabetic ulcers.

Armstrong and colleagues demonstrated that nearly one-third of diabetic patients will develop a foot ulcer in their lifetime, with neuropathy being the most important risk factor [17]. Our study reflected a similar pattern, as neuropathic loss of sensation was common among 34% of patients with diabetic ulcers. Dayya et al. further emphasized that repeated sharp debridement plays a crucial role in diabetic ulcer management, a finding consistent with our frequent use of surgical debridement in this group [18].

Population studies often cite arterial ulcers as comprising 5–10% of all chronic lower limb ulcers. However, in our study, arterial ulcers accounted for 17%. Humphries and colleagues reported that ischemic ulcers are frequently associated with absent peripheral pulses and a higher risk of amputation, findings which were consistent with our observations [19].

Smoking and hypertension were strongly associated with arterial and diabetic ulcers in our cohort. Humphries et al. also identified smoking as a significant predictor of peripheral arterial disease and ulcer-related amputations [19]. This similarity underlines the need for early lifestyle modification in patients with lower limb ulcers.

Debridement was commonly required in diabetic and venous ulcers in our study. Elraiyah and colleagues, in their systematic review, demonstrated that regular sharp debridement accelerates healing of diabetic foot ulcers [20]. Lumbar sympathectomy was selectively performed in patients with critical limb ischemia in our cohort. Karanth et al. reported that sympathectomy may provide symptomatic relief in carefully selected cases with non-reconstructable ischemia [21]. Amputation was required in 44% of our cohort, mostly in arterial and diabetic ulcers. This proportion is higher than community-based studies but aligns with tertiary surgical referral data. Humphries et al. observed that amputation rates remain high among patients with combined diabetes and peripheral arterial disease, despite advances in revascularization [19].

Limitations

The limitations of our study include its single-centre design, convenience sampling, and lack of long-term follow-up for ulcer healing. Further multicentric studies with larger samples and standardized vascular assessments are needed for better generalizability.

Conclusions

Our findings emphasize the importance of early detection of diabetes- and ischemia-related ulcers, aggressive debridement, vascular assessment, and risk-factor modification. A multidisciplinary approach involving surgeons, vascular specialists, and wound-care teams remains essential to improve limb salvage and reduce amputation rates.

Conflict of Interest: Nil

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