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Clinical Evaluation of Vasculopathy in Diabetic Foot and its Impact on Surgical Outcomes

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ABSTRACT
Diabetic foot complications pose a significant healthcare challenge, with vasculopathy being a major contributing factor. This study aimed to assess the prevalence of vasculopathy in diabetic foot patients and investigate its impact on surgical outcomes. We conducted a cross-sectional study involving 100 diabetic foot patients. Patient demographics, including age, gender, diabetes duration, and comorbidities, were recorded. Vasculopathy was assessed through ankle-brachial index (ABI), with a mean ABI of 0.65 (SD = 0.12). Surgical outcomes, including wound healing rates, amputation rates, infection rates and length of hospital stay, were monitored. Patient-reported outcomes were assessed using a quality of life questionnaire. Among the study population, 70% of patients (n = 70) were diagnosed with vasculopathy based on an ABI of <0.9. Patients with vasculopathy demonstrated distinct outcomes. A 40% rate of complete wound healing within 12 weeks compared to 85% in patients without vasculopathy. Major amputation rates were significantly higher in the vasculopathy group (15%) compared to the non-vasculopathy group (2%). Infection rates were also elevated in patients with vasculopathy (25% vs. 12%). Furthermore, patients with vasculopathy had a longer mean hospital stay (10.4 days vs. 7.2 days) and reported lower quality of life scores (mean score = 45.6 vs. 62.8). Vasculopathy significantly influences surgical outcomes in diabetic foot patients, with higher amputation rates, longer hospital stays and diminished quality of life. Early identification and intervention for vasculopathy in diabetic foot patients are crucial to improve clinical outcomes and patient well-being. These findings underscore the importance of a comprehensive approach to managing diabetic foot complications that includes addressing vasculopathy as a primary concern.

INTRODUCTION

Diabetes mellitus, a global epidemic affecting millions, presents a complex web of challenges to both patients and healthcare systems[1]. Among its myriad complications, diabetic foot disease stands as a formidable adversary, characterized by chronic ulcers, neuropathy and impaired circulation[2]. These complications can culminate in a range of debilitating consequences, from recurrent infections to lower extremity amputations[3]. Central to the understanding and management of diabetic foot disease is the recognition of vasculopathy, a vascular disorder that significantly contributes to the development and progression of foot ulcers.

Vasculopathy in the context of diabetic foot disease encompasses a spectrum of vascular abnormalities, most notably the reduction in blood flow to the lower extremities. This diminished perfusion, often assessed using the ankle-brachial index (ABI) among other measures, plays a pivotal role in the impaired wound healing and increased susceptibility to infections seen in diabetic patients[4]. Understanding the prevalence and impact of vasculopathy in this population is crucial for tailoring effective interventions and optimizing surgical outcomes[5].

Despite advances in diabetes management and wound care, the burden of diabetic foot complications remains substantial. Patients with diabetic foot ulcers and concomitant vasculopathy face a particularly daunting challenge. Timely and accurate diagnosis of vasculopathy is a critical step in the management of these patients. It not only aids in risk stratification but also guides treatment decisions, potentially reducing the need for major amputations and improving overall patient quality of life.

The aim of this study is to comprehensively evaluate the presence and impact of vasculopathy in diabetic foot patients and elucidate its role in surgical outcomes. We will assess the prevalence of vasculopathy using the ABI and examine its association with wound healing rates, amputation rates, infection rates, length of hospital stay and patient-reported outcomes. By examining these factors, we seek to enhance our understanding of the complex interplay between vasculopathy and surgical outcomes in diabetic foot disease.

Aim and objectives: The primary aim of this study is to determine the prevalence of vasculopathy in diabetic foot patients and investigate its impact on surgical outcomes. Specifically, our objectives are as follows:

- To assess the prevalence of vasculopathy in a cohort of diabetic foot patients using the ankle-brachial index (ABI) and other relevant vascular parameters
- To examine the association between vasculopathy and wound healing rates, measured at 12 weeks post-surgery
- To evaluate the impact of vasculopathy on amputation rates among diabetic foot patients during the study period
- To analyze the correlation between vasculopathy and infection rates in diabetic foot patients
- To investigate the influence of vasculopathy on the length of hospital stay in diabetic foot patients undergoing surgical interventions
- To assess the effect of vasculopathy on patient-reported outcomes, particularly quality of life, using a validated questionnaire

MATERIALS AND METHODS

Study design: This research was designed as a retrospective cross-sectional study conducted at Kakatiya Medical College, Warangal, Telangana, India, spanning from January 2019 to December 2019. The study aimed to investigate the prevalence of vasculopathy in diabetic foot patients and its impact on surgical outcomes.

Study population: The study included a cohort of diabetic foot patients who presented to the hospital for evaluation and surgical intervention during the specified study period. Inclusion criteria encompassed individuals diagnosed with diabetes mellitus, aged 18 years or older, with confirmed diabetic foot ulcers. Patients with incomplete medical records or those who did not consent to participate were excluded.

Data collection

Patient demographics: Detailed demographic data were collected for each participant, including age, gender, duration of diabetes and comorbidities. This information was extracted from electronic medical records and patient interviews.

Vasculopathy assessment: Vasculopathy was assessed using the ankle-brachial index (ABI) as the primary measure. The ABI was measured using standard methods, with values <0.9 indicative of vasculopathy. Additional vascular parameters, such as pulse volume recordings (PVRs) and Doppler ultrasound findings, were also considered to corroborate the diagnosis of vasculopathy.

Surgical outcomes: Surgical outcomes were evaluated through meticulous record review. These outcomes included wound healing rates, amputation rates, infection rates, length of hospital stay and patient-reported outcomes.

Wound healing rates: Wound healing was assessed at 12 weeks post-surgery. The presence of complete wound closure and any complications or delays in healing were documented.

Amputation rates: The occurrence and type of amputations (major or minor) were recorded for each patient during their hospital stay.

Infection rates: Infection rates were determined by reviewing clinical records for documented infections, their type (e.g., cellulitis, osteomyelitis) and the interventions provided.

Length of hospital stay: The length of hospitalization for each patient was calculated from the date of admission to the date of discharge.

Patient-reported outcomes: Patients were administered a validated quality of life questionnaire to assess their well-being and satisfaction with surgical outcomes.

Data analysis: Data analysis was performed using statistical software (e.g., SPSS). Descriptive statistics, including means, standard deviations, frequencies, and percentages, were used to summarize the data. Bivariate and multivariate analyses were employed to examine the relationships between vasculopathy and surgical outcomes, controlling for potential confounders.

Ethical considerations: This study adhered to ethical principles and received approval from the Institutional Ethics Committee of Kakatiya Medical College. Informed consent was obtained from all participants and confidentiality of patient data was maintained throughout the study.

RESULTS

Patient demographics:

- **Age:** The mean age of the study population was 62.5 years (SD = 7.3), with a range of 45-78 years
- **Gender:** The study included 55 male patients (55%) and 45 female patients (45%)
- **Diabetes duration:** The mean duration of diabetes among participants was 13.8 years (SD = 4.2)
- **Comorbidities:** The most common comorbidities included hypertension (n = 72, 72%), hyperlipidemia (n = 38, 38%) and obesity (n = 25, 25%) (Table 1)

Vasculopathy assessment:

- **Ankle-brachial index (ABI):** The mean ABI for the study population was 0.65 (SD = 0.12), with a range of 0.45-0.85

Table 1: Patient demographics

Characteristic	Mean (SD)	Range
Age (years)	62.5 (7.3)	45 - 78
Gender (male/female)	55/45	
Diabetes duration (years)	13.8 (4.2)	
Comorbidities		
• Hypertension		72% (n = 72)
• Hyperlipidemia		38% (n = 38)
• Obesity		25% (n = 25)

Table 2: Vasculopathy assessment

Assessment	Mean (SD)	Range
Ankle-brachial index (ABI)	0.65 (0.12)	0.45-0.85
Prevalence of vasculopathy		70% (n = 70)

Table 3: Surgical outcomes

Outcome	Vasculopathy	No vasculopathy
Wound healing rates (%)	40%	85%
Amputation rates (%)	15%	2%
Infection rates (%)	25%	12%
Length of hospital stay (days)	10.4 (3.2)	7.2 (2.5)
Patient-reported outcomes (quality of life)	45.6 (10.3)	62.8 (8.9)

- **Prevalence of vasculopathy:** Among the 100 diabetic foot patients, 70 patients (70%) were diagnosed with vasculopathy based on an ABI of <0.9 or other relevant criteria (Table 2)

Surgical outcomes

- **Wound healing rates:** Wound healing rates were assessed at 12 weeks post-surgery. Among the patients with vasculopathy, 40% experienced complete wound healing within 12 weeks, compared to 85% of patients without vasculopathy (Table 3)
- **Amputation rates:** During the study period, 15 patients with vasculopathy (15%) required major amputation (above or below the knee), while only 2 patients without vasculopathy (2%) required major amputation
- **Infection rates:** Infections occurred in 25% of patients with vasculopathy and 12% of patients without vasculopathy
- **Length of hospital stay:** The mean length of hospital stay for patients with vasculopathy was 10.4 days (SD = 3.2), while for those without vasculopathy, it was 7.2 days (SD = 2.5)
- **Patient-reported outcomes:** Patient-reported outcomes were assessed using a quality of life questionnaire. Patients with vasculopathy reported lower quality of life scores (mean score = 45.6, SD = 10.3) compared to those without vasculopathy (mean score = 62.8, SD = 8.9).

DISCUSSIONS

Diabetic foot complications remain a critical healthcare challenge globally, with vasculopathy being a significant contributor to the severity and progression of these complications. The findings shed light on the intricate relationship between

vasculopathy and surgical results and they can be compared to prior studies to enhance our understanding and inform clinical practices.

The prevalence of vasculopathy in our study population, estimated at 70% based on an ankle-brachial index (ABI) of <0.9, aligns with findings from previous valid studies. Abbott *et al*.[6] reported a similar prevalence rate of 68% among diabetic foot patients in a multi-center study. This consistency underscores the high burden of vasculopathy in this patient group and the need for early detection and intervention.

One of the key findings of our study was the significant impact of vasculopathy on wound healing rates. Patients with vasculopathy had a notably lower rate of complete wound healing within 12 weeks (40%) compared to those without vasculopathy (85%). This observation corroborates the results of a recent meta-analysis by Yu *et al*.[7] which indicated that impaired vascular perfusion is a substantial barrier to wound healing in diabetic foot ulcers. The delayed wound healing associated with vasculopathy underscores the urgency of vascular assessment and intervention in diabetic foot care.

Amputation rates were also substantially affected by the presence of vasculopathy in our study. A striking 15% of patients with vasculopathy required major amputations (above or below the knee), whereas only 2% of patients without vasculopathy faced such outcomes. These findings concur with those of Stancu *et al*.[8] who reported a six-fold increase in major amputations among diabetic foot patients with vasculopathy compared to those without. The link between vasculopathy and major amputations is evident and highlights the critical role of vascular evaluation in preventing these devastating outcomes. Infection rates were notably higher in patients with vasculopathy (25%) compared to those without vasculopathy (12%). This finding aligns with the observations of Shobhana *et al*.[9] who reported a higher incidence of wound infections in diabetic foot patients with vascular compromise. The impaired blood flow associated with vasculopathy not only delays wound healing but also increases the susceptibility to infections, emphasizing the need for vigilant wound care in these individuals.

The extended length of hospital stay observed in patients with vasculopathy (mean of 10.4 days) compared to those without vasculopathy (mean of 7.2 days) is consistent with the results of a study by Tennvall *et al*.[10]. Their research highlighted the economic burden associated with prolonged hospitalization in diabetic foot patients with vascular complications, further underscoring the importance of timely vascular assessment and intervention.

Patient-reported outcomes revealed a considerable difference in quality of life scores between the two groups, with patients with vasculopathy reporting significantly lower scores (mean = 45.6) compared to those without vasculopathy (mean = 62.8). These results are in line with the findings of Tennvall *et al*.[10] who emphasized the negative impact of vasculopathy on the psychological and physical well-being of diabetic foot patients.

CONCLUSION

Our study contributes to the growing body of evidence on the prevalence and impact of vasculopathy in diabetic foot patients. The findings align with prior valid studies, demonstrating the consistent association between vasculopathy and adverse surgical outcomes, including delayed wound healing, increased amputation rates, higher infection rates, extended hospital stays and reduced quality of life. These results underscore the critical importance of early vascular assessment and intervention in the comprehensive management of diabetic foot complications, with the ultimate goal of improving patient outcomes and quality of life.

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