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Original Article

ANAEMIA AND ITS ASSOCIATION WITH DIABETIC FOOT ULCER – A CROSS-SE CTIONAL STUDY

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ABSTRACT

Background: Diabetic foot ulcers (DFUs) are a serious complication of diabetes mellitus, leading to significant morbidity and risk of amputation. Recent studies suggest that anaemia, a common comorbidity in diabetic patients, may exacerbate the severity and delay the healing of DFUs. This paper aims to explore the association between anaemia and diabetic foot ulcers and the spectra of different types of anaemia in such cases.

Materials and methods: A cross-sectional study was done involving 190 patients from December 2024 to January 2025 in the Department of General surgery, Bangalore Medical College and Research Institute, Bengaluru, Karnataka and the hospitals attached to it. After receiving the institutional ethical committee clearance, the study was conducted. Data collected from all these patients after the application of inclusion and exclusion criteria. Data such as Sociodemographic data and relevant investigations were collected and noted. Investigations including blood haemoglobin levels, peripheral smear, serum vitamin B 12 levels, serum Folate levels, Iron profile were collected and analysed. Anaemia was defined based on WHO criteria: haemoglobin <13 g/dL in males and <12 g/dL in females.

Results: Majority of the population group studied were males i.e., 52.1% of the study group and belonged to 31-40yrs of age with mean age being 52.29 yrs. amongst the peripheral smears studied 33.2% of the group had normal study whereas 30% had normocytic normochromic picture, 23.7% had microcytic hypochromic picture, 6.8% had Megaloblastic anaemia, 6.3% had dimorphic anaemia. There was no significant relationship between age and hba1c or age and haemoglobin levels.

Conclusions: The prevalence of anaemia was high in the DFU and most of the patients with DFU have predominantly normocytic normochromic smear picture followed by microcytic hypochromic blood picture. Anaemia is highly prevalent among patients with diabetic foot ulcers hence routine evaluation and correction of anaemia should be considered an essential component of DFU management strategies.

Keywords: *Anaemia, Diabetic foot ulcers, haemoglobin, peripheral smear.*

INTRODUCTION

Diabetes mellitus (DM) is a chronic metabolic disorder and a rising global pandemic characterized by hyperglycemias resulting from defects in insulin secretion, insulin action, or both. Over the past few decades, the prevalence of diabetes has risen dramatically, making it one of the major public health challenges globally. Among the various complications of diabetes, diabetic foot ulcers (DFUs) represent a serious and common condition affecting approximately 15% of diabetic patients during their lifetime [1]. DFUs often result in prolonged hospitalisation, frequent infections, and are the leading

cause of non-traumatic lower limb amputations worldwide [2]. DFUs are primarily caused by a combination of peripheral neuropathy, peripheral arterial disease, and impaired immune function. While these factors are well established, growing evidence suggests that systemic conditions like anaemia may also play a pivotal role in the pathogenesis and healing outcomes of DFUs. Anaemia, defined by a reduction in the oxygen carrying capacity of the blood, is frequently observed in individuals with chronic illnesses, including diabetes [4]. The prevalence of anaemia in diabetic patients can be attributed to several factors, including renal insufficiency, chronic inflammation, nutritional deficiencies, and the presence of co morbid infections. Inadequate tissue oxygenation due to anaemia can impair wound healing by affecting various physiological processes such as collagen synthesis, angiogenesis, and resistance to infections [3]. However, despite its high prevalence and potential impact, anaemia is often overlooked in the clinical management of DFUs. Recognizing the influence of anaemia on DFUs could lead to more comprehensive and effective treatment approaches.

This study aims to investigate the association between anaemia and diabetic foot ulcers and evaluate its implications for prognosis and clinical outcome and to investigate the spectra of different types of anaemia in such cases.

MATERIALS AND METHODS:

A cross-sectional study was done involving 190 patients from December 2024 to January 2025 in the Department of General surgery, Bangalore Medical College and Research Institute, Bengaluru, Karnataka and the hospitals attached to it. After receiving the institutional ethical committee clearance, the study was conducted. The outpatients and inpatients who present to the department of general surgery, Victoria hospital who are previously diagnosed with diabetes or newly detected diabetes are taken as part of the study who undergo blood sampling for anaemia profile mainly vitamin b12 levels and iron profile and peripheral smear. Data was collected from all these patients after the application of inclusion and exclusion criteria.

Inclusion criteria:

1. Patients aged > 18yrs, of either sex.
2. Patients willing to give a written and informed consent.
3. Patients with diagnosed diabetes mellitus with diabetic foot ulcers

Exclusion criteria:

1. Patients suffering from malignancy.
2. End stage renal disease.
3. Patients with known Psychiatry disorders
4. Patients with purely vascular ulcers and traumatic ulcers
5. Patients diagnosed with anemia due to other causes such as occult blood loss and other systemic illnesses leading to bleeding manifestations

Data collections: Data such as Sociodemographic data and relevant investigations were collected and noted. Investigations including blood haemoglobin levels, peripheral smear, serum vitamin B 12 levels, serum Folate levels, Iron profile were collected and noted.

Statistical analysis: To describe about the data descriptive statistics frequency analysis, percentage analysis was used for categorical variables and the mean & S.D were used for continuous variables. To assess the relationship between the variables Pearson's Correlation was used. In the above statistical tool, the probability value 0.05 is considered as significant level

RESLTS

Table 1: Age and Gender distribution among the study Participants

Variables		Frequency	Percent
Age (In Years)	21 - 30 yrs	11	5.8%
	31 - 40 yrs	48	25.3%
	41 - 50 yrs	46	24.2%
	51 - 60 yrs	24	12.6%
	61 - 70 yrs	23	12.1%
	71 - 80 yrs	23	12.1%
	Above 80 yrs	15	7.9%
Gender	Female	91	47.9%
	Male	99	52.1%
Peripheral smear	Dimorphic Anaemia	12	6.3

picture (PSP)	Megaloblastic Anaemia	13	6.8
	Microcytic Hypochromic	45	23.7
	Normal	63	33.2
	Normocytic Normochromic Anaemia	57	30.0

The Above table shows Age distribution where 21 - 30 yrs is 5.8%, 31 - 40 yrs is 25.3%, 41 - 50 yrs is 24.2%, 51 - 60 yrs is 12.6%, 61 - 70 yrs is 12.1%, 71 - 80 yrs is 12.1%, Above 80 yrs is 7.9% and Gender distribution where Female is 47.9%, Male is 52.1%.

Table 2: Peripheral smear picture (PSP) distribution among the study Participants

Variables		**Frequency**	**Percent**
Peripheral smear picture (PSP)	Dimorphic Anaemia	12	6.3
	Megaloblastic Anaemia	13	6.8
	Microcytic Hypochromic	45	23.7
	Normal	63	33.2
	Normocytic Normochromic Anaemia	57	30.0

PSP distribution where Dimorphic Anaemia is 6.3%, Megaloblastic Anaemia is 6.8%, Microcytic Hypochromic is 23.7%, Normal is 33.2%, Normocytic Normochromic Anaemia is 30.0%.

Table 3: Correlations of HBA1C with Hb by using Pearson Correlation

Correlations		
		Hb
HBA1C	Pearson Correlation	-.216**
	p-value	0.003 **
	N	190
Statistical Significance at p < 0.01 level		

The above table shows the Correlation of HBA1C with Hb by Pearson Correlation where Pearson Correlation = -.216, p = 0.003 <0.01 which shows a highly statistically significant negative Correlation at p < 0.01 level.

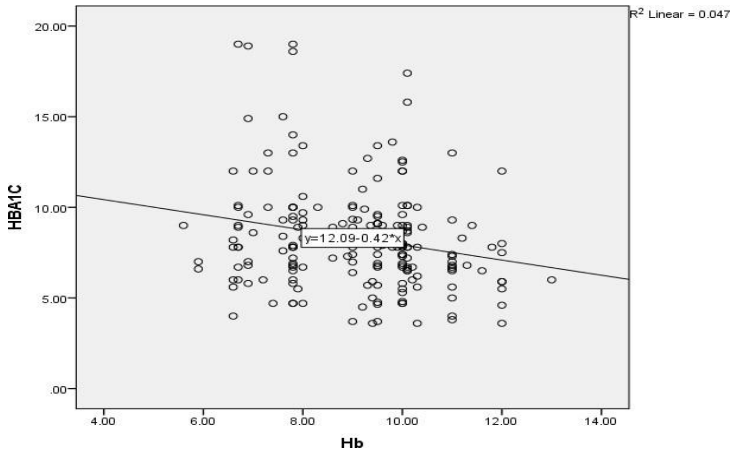

Figure 1: Correlations of HBA1C with Hb by using Pearson Correlation

Table 4: Correlations of Age with Hb by using Pearson Correlation

Correlations		
		Hb
Age	Pearson Correlation	.035
	p-value	0.630 #
	N	190
#No Statistical Significance at p >0.05 level		

The above table shows the Correlation of Age with Hb by Pearson Correlation where Pearson Correlation = 0.035, p = 0.630 >0.05 which shows no statistically significant positive Correlation at p > 0.05 level.

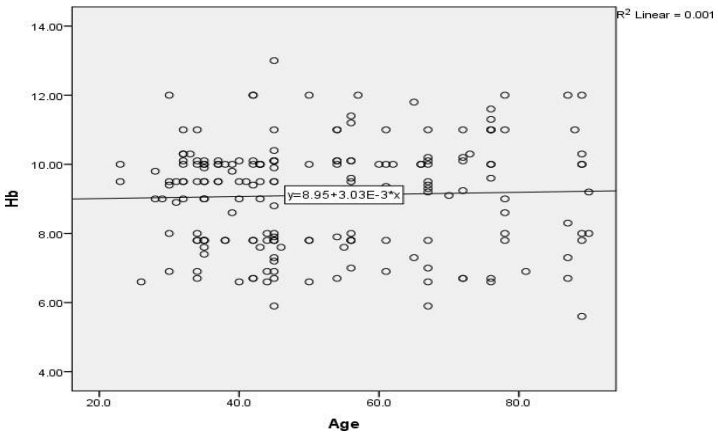

Figure 2: Correlations of Age with Hb by using Pearson Correlation

Table 5: Correlations of Age with HBA1C by using Pearson Correlation

Correlations		
		HBA1C
Age	Pearson Correlation	.005
	p-value	0.943 #
	N	190
#No Statistical Significance at p>0.05 level		

The above table shows the Correlation of Age with HBA1C by Pearson Correlation where Pearson Correlation=0.005, p=0.943>0.05 which shows no statistically significant positive Correlation at p > 0.05 level.

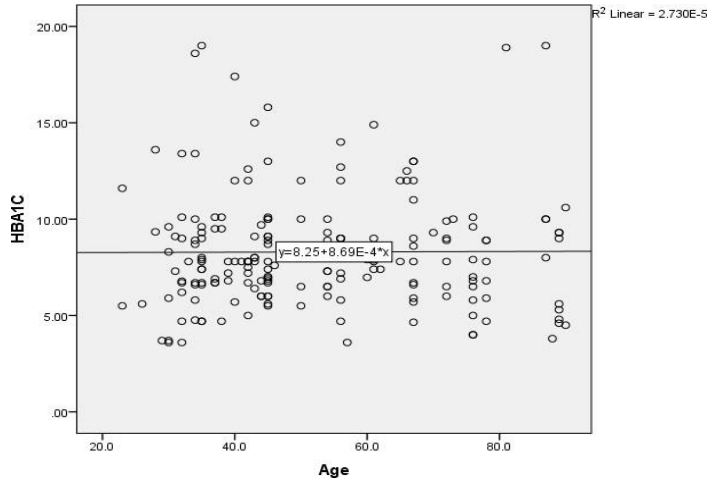

Figure 3: Correlations of Age with HBA1C by using Pearson Correlation

Table 6: Descriptive Statistics

Descriptive Statistics					
	N	**Minimum**	**Maximum**	**Mean**	**SD**
Age	190	23.0	90.0	52.29	17.81
HBA1C	190	3.60	19.00	8.30	2.96
Hb	190	5.60	13.00	9.11	1.54
S.VIT B12	190	100.0	785.0	350.56	154.57
S. Folic acid	190	1.0	13.0	5.74	2.73
S Iron	190	21.0	180.0	74.93	37.09

The above table shows Descriptive Statistics of Age, HBA1C, Hb, S.VITB12, S. Folic acid, S Iron.

DISCUSSION

The present study analyzed the relationship between hematological parameters, glycemic control, and demographic characteristics in diabetic foot ulcer patients.

In our study the majority of participants belonged to the 31–50 years age group, reflecting the age range most affected by lifestyle-related disorders such as diabetes and anemia. Similar age trends have been observed in previous studies done by Patel et al [5], and Gupta et al [6].showing that middle-aged adults are at higher risk of developing metabolic and hematological abnormalities due to increased oxidative stress and nutritional imbalance.

In terms of gender distribution, males slightly outnumbered females in the current study. Although anemia is more commonly associated with females due to menstrual and nutritional factors, the nearly equal distribution may indicate the influence of chronic diseases such as diabetes or renal disorders that equally affect both genders, in accordance with the Sharma et al [7].

We have found that normocytic normochromic anemia and microcytic hypochromic anemia were predominant, while Megaloblastic and dimorphic anemias accounted for smaller proportions among the peripheral smear findings. The high proportion of normocytic anemia is consistent with findings of Thomas et al [8], common in chronic diseases, including diabetes mellitus, where anemia develops due to inadequate erythropoietin response and chronic inflammation. Microcytic hypochromic patterns suggest iron deficiency, possibly linked to dietary insufficiency or chronic blood loss, in agreement with the Kassebaum et al [9].

In the present study a statistically significant negative correlation was found between HbA1C and Hb levels ($r = -0.216$, $p = 0.003$), indicating that as hemoglobin decreases, HbA1C levels tend to increase. This inverse relationship highlights how anemia can falsely elevate HbA1C levels, leading to potential overestimation of glycemic control in diabetic patients. Several studies have supported this observation, suggesting that HbA1C interpretation should consider hemoglobin status to avoid misleading clinical conclusions, similar results observed by Kim et al [10] and Sumner et al [11].

The correlation between Age and Hb ($r = 0.035$, $p = 0.630$) and between Age and HbA1C ($r = 0.005$, $p = 0.943$) were not statistically significant in this research, implying that age alone does not significantly influence hemoglobin or HbA1C levels within this cohort. This contrasts with Selvin et al [12], reported that mild age-related increases in HbA1C, suggesting that other confounding factors—such as diet, comorbidities, and medication—may have minimized the effect in this study.

The descriptive data showed a lower mean Hb, confirming that the majority of participants were anemic. The higher mean HbA1C reflects poor glycemic control on average. Furthermore, mean serum Vitamin B12 and serum folic acid were within or near lower normal limits, suggesting possible subclinical deficiencies contributing to the anemia pattern observed. The mean serum iron level also indicates that iron deficiency may play a substantial role in the hematological profile of this group.

Overall, the study demonstrates a significant relationship between hemoglobin and HbA1C levels, highlighting the importance of evaluating anemia status before interpreting glycemic control using HbA1C. No significant correlation was found between age and these parameters, suggesting that anemia and poor glycemic control may occur independently of age in the studied population.

CONCLUSION

The present study demonstrates that anemia and glycemic control are closely interlinked. The findings revealed a significant negative correlation between HbA1C and hemoglobin levels, suggesting that anemia can lead to falsely elevated HbA1C values. Therefore, clinicians should interpret HbA1C results cautiously, especially in patients with low hemoglobin, to avoid overestimation of glycemic control. Most participants exhibited normocytic normochromic and microcytic hypochromic anemia, highlighting the coexistence of nutritional deficiencies and chronic disease–related anemia. The absence of a significant correlation between age and either Hb or HbA1C indicates that anemia and poor glycemic status occur across all age groups.

The study emphasizes the importance of comprehensive hematological evaluation, including assessment of serum iron, folate, and vitamin B12 levels, in patients undergoing glycemic monitoring. Integrating these parameters can enhance diagnostic accuracy and improve clinical management of both diabetic and anemic patients.

Recommendations

- HbA1C interpretation should always be supported by concurrent hemoglobin and peripheral smear evaluation.
- Screening for nutritional deficiencies, especially iron and vitamin B12, should be part of routine assessment in diabetic and anemic individuals.
- Further large-scale, multicentric studies are recommended to validate these findings and explore underlying pathophysiological mechanisms linking anemia and glycemic control.

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