# Exploring the interplay: Lipid profiles and renal functions in type 2 diabetes at a tertiary care hospital.

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## Abstract

**Background: The assessment of lipid profiles and renal functions is crucial in understanding the multifaceted nature of Type 2 Diabetes Mellitus (T2DM) within the context of healthcare. Tertiary care hospitals play a pivotal role in managing complex medical conditions, and T2DM, being a chronic metabolic disorder, often presents with intricate challenges.**

**Aims and objective: The primary aim of this study is to investigate the correlation between lipid profiles and renal functions in individuals diagnosed with T2DM and also to analyze the relationship between various lipid parameters and markers of renal function among T2DM.**

**Materials and methods: This research included 120 individuals diagnosed with Type 2 Diabetes Mellitus (T2DM) who were hospitalized at a tertiary hospital and research center. The study encompassed both outpatient and inpatient environments. Various tests, including HbA1c, serum creatinine, lipid profile, albumin creatinine ratio, fasting blood sugar, and postprandial blood sugar, were performed through blood and urine samples.**

**Results: The overall blood sugar level measured 2-3 hours after eating was found to be 175.92Â ± 25.188 (range: 120-240). A statistical analysis revealed a mild positive correlation between the lipid profile and fasting blood sugar levels, with a correlation coefficient of 0.035.**

**Conclusion: The findings underscore the significance of monitoring lipid profiles and renal functions for a more comprehensive and targeted approach to managing T2DM in clinical settings. Further research and longitudinal studies are warranted to deepen our understanding and enhance therapeutic strategies for individuals with T2DM.**

**Keywords:** Type 2 Diabetes Mellitus (T2DM), Lipid profiles, Renal functions.

## Introduction

The worldwide impact of Diabetes Mellitus (DM) is significant, affecting an estimated 366 million individuals globally as of 2011. In that year, India contributed to nearly one-sixth of the total diabetes burden, with approximately 62 million people affected. Projections indicate that by 2030, the number of individuals with diabetes in India is expected to increase to 101 million [1,2]. Type 2 Diabetes Mellitus (T2DM) is the most common type of diabetes observed in India, making up over 95% of the diabetic population [2-4]. Persistent high blood sugar levels linked to disruptions in fat and protein processing, when not addressed effectively, can result in enduring vascular issues, immediate metabolic challenges, increased vulnerability to infections, and the development of non-alcoholic fatty liver disease [5-8].

Vascular complications associated with diabetes can be categorized into two main types: Microvascular complications, which impact the retina (resulting in diabetic retinopathy), kidneys (leading to diabetic nephropathy), and peripheral nerves (causing diabetic neuropathy); and macrovascular complications, encompassing coronary artery disease, cerebrovascular disease, and peripheral vascular disease. The occurrence of these complications is a major contributor to premature morbidity and mortality in individuals with diabetes. Notably, diabetic nephropathy stands out as the primary cause of End Stage Renal Disease (ESRD) globally [5].

The initial efforts to address diabetic renal disease in India were carried out with the support of the World Health Organization (WHO) from 1975 to 1978. As part of the Multi National Study of Diabetic Vascular Disease (MNSDVD), conducted across fourteen countries with Delhi, India as one of the centers, the research revealed the prevalence of Diabetic Nephropathy (DN). The study found that among individuals with Diabetes Mellitus (DM) durations of 0-6 years, 9.3% of males and 4.2% of females exhibited DN. For those with DM

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durations of 6-13 years, the rates were 10.7% for males and 5.7% for females. In cases where the DM duration was ≥ 14 years, the observed rates were 23% for males and 13.6% for females [9].

Diabetic kidney disease stands as the primary contributor to end-stage kidney disease in developed nations. However, the development and progression of kidney dysfunction and proteinuria exhibit significant variability across individual cases. Consequently, the categorization of risk based on clinical data and pathological observations becomes crucial. A recent clinico-pathological investigation utilizing kidney biopsy samples from diabetic patients uncovered distinctive pathological alterations in DN, exerting unique influences on prognosis at each clinical stage. Furthermore, a comparative analysis of clinico-pathological findings between DN and hypertensive nephrosclerosis indicated minimal disparities in their pathological presentations among cases featuring low albuminuria and preserved estimated Glomerular Filtration Rate (eGFR). Given the challenges in distinguishing between kidney lesions solely attributable to diabetes and those influenced by factors beyond diabetes, it becomes imperative to validate these overlapping pathological features through kidney biopsy in the early stages of diabetes [10].

Lipid profiles, encompassing cholesterol, triglycerides, and lipoproteins, provide valuable insights into the cardiovascular risk associated with diabetes. Dyslipidemia is a common comorbidity in individuals with T2DM and is known to contribute significantly to cardiovascular complications. Examining lipid profiles in the specific setting of a tertiary care hospital allows for a comprehensive evaluation of the metabolic status and cardiovascular risk in these patients [11].

Simultaneously, renal functions are paramount in T2DM management due to the high prevalence of DN. Chronic Kidney Disease (CKD) is a frequent complication of diabetes, and its progression can have profound implications on patient outcomes. Monitoring renal functions in a tertiary care setting aids in the early detection of any abnormalities, facilitating timely interventions and better disease management.

This study aims to investigate the lipid profiles and renal functions of individuals with T2DM at a tertiary care hospital. By exploring these parameters, the research endeavors to enhance our understanding of the interplay between diabetes, cardiovascular risk, and renal complications in a specialized medical setting. The findings may contribute to the development of targeted interventions and improved clinical strategies for the holistic management of T2DM in tertiary care settings.

## Materials and Methods

### *Source of data collection*

This research took place in the medicine Out Patient Department (OPD)and Inpatients (IPD) at BLDE (DU) Shri. B.M.Patil Medical College, Hospital, and Research Centre in Vijayapura. All participants in the study were informed about the research, and their informed written consent was obtained. The subjects included in the study were individuals diagnosed with T2DM referred by an endocrinologist over a 12-month period from November 2022 to November 2023.

### *Sampling method*

This research employed a convenience sampling method, selecting individuals with T2DM who were present during the sample collection period and met the specified criteria. A total of 120 subjects, comprising both males and females, were recruited. The inclusion criteria stipulated a minimum of five years of T2DM. However, individuals with Type 1 Diabetes Mellitus (T1DM), pregnant women, those with renal impairment, thyroid disorders, and other coexisting health conditions were excluded from participation in the study.

### *Procedure*

A data collection form was employed to gather information from each patient during interviews. Various demographic factors, including age, gender, duration of diabetes, medical history, family history, occupation, and marital status, were recorded. Anthropometric measurements were taken in the morning, with patients wearing light clothing and no shoes. Weight was measured using a digital scale, while height was determined using a stadiometer. Body Mass Index (BMI) was calculated using Quellet's equation (BMI ($kg/m^2$)=weight (kg)/ height$^2$ ($m^2$)) w. Systolic and diastolic blood pressure were measured on the right arm in a sitting position using a standardized mercury sphygmomanometer. Fasting blood glucose, blood urea, serum creatinine, Urinary Albumin-to-Creatinine Ratio (UACR), and lipid profile were assessed using the Johnson and Johnson (Vitros 5.1) fully automated machine. The HbA1c test was conducted with BioRad 10 DM, employing the High-Performance Liquid Chromatography (HPLC) principle.

To review results, medical records from previous patient visits were consulted, or new readings obtained during data collection were considered. A 5 ml venous blood sample was collected in the morning after 8-12 hours of nocturnal fasting by a phlebotomist. Lipid profile parameters (Total Cholesterol (TC), Triglycerides (TG), HDL, and LDL) were part of the routine follow-up assessments conducted at the time of data collection.

### *Inclusion criteria*

Individuals who have been diagnosed with T2DM for at least five years are eligible for inclusion in the study. Both males and females can participate, given their willingness to undergo lipid profile assessments. Moreover, individuals with existing renal function data are encouraged to participate in the research.

### *Exclusion criteria*

Exclusion criteria for the study include individuals with T1DM, pregnant women, individuals with known renal

impairment, participants with thyroid disorders, and those with other significant co-morbid conditions affecting lipid metabolism or renal function.

### *Statistical analysis*

Data analysis was performed using SPSS software version 26, involving the utilization of Spearman's correlation to examine the associations among blood sugar, HbA1c, and eGFR with blood urea, serumcreatinine, TC, TG, HDL, LDL, and VLDL. Quantitative data were summarized using mean and standard deviation calculations. Scatter plots were generated to visually represent the correlations between the variables.

## Results

Table 1 presents the fundamental demographic features, including age in years, duration, Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), Height in centimeters, weight in kilograms, and Body Mass Index (BMI).

***Table 1.*** *Baseline demographic characteristics.*

| Variables | Overall (n=120) | Male (n=56) | Females (n=64) | Mann-Whitney U test |
|---|---|---|---|---|
| | Mean ± SD (Min-Max) | Mean ± SD (Min-Max) | Mean ± SD (Min-Max) | |
| Age(years) | 55.64 ± 5.595 (41-69) | 55.71 ± 5.65 (42-68) | 55.58 ± 5.589 (41-69) | P=0.652 |
| Duration | 8.12 ± 0.97 (7-10) | 8.18 ± 1.03 (7-10) | 8.06 ± 0.924 (7-10) | P=0.554 |
| SBP | 130.33 ± 9.06 (100-140) | 132.32 ± 8.74 (120-140) | 128.59 ± 9.06 (100-140) | P=0.027* |
| DBP | 73.67 ± 7.55 (60-90) | 74.29 ± 8.28 (60-90) | 73.13 ± 6.87 (60-90) | P=0.485 |
| Height (cm) | 153.20 ± 6.43 (139-168) | 155.18 ± 6.59(141-168) | 151.47 ± 5.80 (139-162) | P=0.004* |
| Weight (kg) | 59.76 ± 5.94 (48-76) | 61.61 ± 6.62 (49-76) | 58.14 ± 4.76 (48-66) | P=0.005* |
| BMI | 25.39 ± 0.99 (23.7-29.3) | 25.498 ± 1.14 (23.7-29.3) | 25.30 ± 0.86 (23.7-27.9) | P=0.413 |
| **Note:** *:Statistically significant | | | | |

Table 2 displays a range of biochemical indicators, encompassing HbA1c, eGFR Serum Creatinine (SER. CREAT), blood urea, Total Cholesterol (TC), Triglycerides (TG), High-Density Lipoprotein Cholesterol (HDL-C), Low-Density Lipoprotein Cholesterol (LDL-C), Very-Low-Density Lipoprotein (VLDL), fasting blood sugar, and postprandial blood sugar levels after an 8-12 hour period.

***Table 2.*** *Biochemical parameters.*

| Variables | Overall (n=120) | Male (n=56) | Female (n=64) | Mann-Whitney U test |
|---|---|---|---|---|
| | Mean ± SD (Min-Max) | Mean ± SD (Min-Max) | Mean ± SD (Min-Max) | |
| HbA1c | 7.56 ± 0.904 (6.10-9.40) | 7.543 ± 0.886 (6.2-9.3) | 7.597 ± 0.927 (6.1-9.4) | P=0.754 |
| eGFR | 84.28 ± 17.18 (46-115.8) | 91.36 ± 15.09 (53.2-115.8) | 78.09 ± 16.59 (46-107.2) | P=0.001* |
| SER. CREAT | 0.849 ± 0.169 (0.60-1.40) | 0.89 ± 0.167 (60-1.40) | 0.813 ± 0.164 (0.6-1.2) | P=0.017* |
| Blood urea | 19.43 ± 4.19 (10-28) | 19.39 ± 4.04 (11-28) | 19.47 ± 4.34 (10-28) | P=0.554 |
| TC | 174.44 ± 11.54 (145.5-199.4) | 174.88 ± 10.91 (145.5-196.7) | 173.88 ± 12.113 (145.9-199.4) | P=0787 |
| TG | 133.82 ± 7.64 (121.2-154.3) | 132.89 ± 7.46 (121.2-154.3) | 134.64 ± 7.76 (123.2-153.4) | P=0.636 |
| HDL-C | 41.55 ± 6.49 (31.2-59.1) | 42.574 ± 7.13 (31.2-59.1) | 40.67 ± 5.81 (31.6-54.3) | P=0.144 |
| LDL-C | 117.58 ± 7.94 (103.7-134.8) | 117.4 ± 7.88 (103.7-129.9) | 117.75 ± 8.06 (103.7-134.8) | P=0.1895 |
| VLDL | 35.71 ± 4.40 (24.6-47.1) | 36.06 ± 4.40 (25.4-47.1) | 35.41 ± 4.43 (24.6-42.8) | P=0.486 |
| Blood sugar(fasting) | 96.50 ± 15.59 (70-120) | 97.14 ± 15.81 (70-120) | 95.94 ± 15.50 (70-120) | P=0.688 |
| Blood sugar after 8-12 hr after eating | 175.92 ± 25.19 (120-240) | 175.18 ± 26.43 (120-240) | 176.56 ± 24.25 (120-234) | P=0.685 |
| **Note**: *:Statistically significant | | | | |

Table 3 illustrates the relationship between the lipid profile and fasting blood sugar levels. The Spearman correlation analysis yielded a significant with a ($p=0.035^*$), correlation between VLDL and fasting blood sugar. This indicates that variations in VLDL levels are associated with changes in fasting blood sugar.

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***Table 3.*** *Correlation between lipid profiles with fasting blood sugar.*

| Spearman correlation | TC | TG | HDL-C | LDL-C | VLDL |
|---|---|---|---|---|---|
| r | -0.033 | -0.106 | -0.123 | 0.042 | 0.192 |
| P value | 0.72 | 0.251 | 0.182 | 0.647 | 0.035* |
| Remark | No correlation and statistically insignificant | Mild negative correlation and statistically insignificant | Mild negative correlation and statistically insignificant | No correlation and statistically insignificant | Mild positive correlation and statistically significant |

Table 4 illustrates the correlation between the lipid Profile Postprandial Blood Sugar (PPBS). The spearman correlation analysis revealed a mild negative correlation between VLDL and PPBS (r=-0.048, p=0.599). The negative sign indicates that as VLDL levels decrease, PPBS tends to increase, and vice versa. This correlation was found to be statistically insignificant.

***Table 4.*** *Correlation between lipid profiles PPBS.*

| Spearman correlation | TC | TG | HDL-C | LDL-C | VLDL |
|---|---|---|---|---|---|
| r (PPBS) | 0.015 | -0.106 | 0.106 | 0.1 | -0.048 |
| P value | 0.87 | 0.472 | 0.467 | 0.282 | 0.599 |
| Remark | No correlation and statistically insignificant | Mild negative correlation and statistically insignificant | Mild positive correlation and statistically insignificant | Mild positive and statistically insignificant | No correlation and statistically insignificant |

The Table 5 presents the Spearman correlation coefficients (r values) and corresponding p-values for the correlation between lipid profiles and Estimated Glomerular Filtration Rate (eGFR). The p-values indicate statistical significance, suggesting that there is a significant correlation between eGFR and Total Cholesterol (TC) as well as VLDL Cholesterol, while the other lipid profiles (TG, HDL-C, and LDL-C) do not show significant correlations with eGFR based on the given p-values.

***Table 5.*** *Correlation between lipid profiles with eGFR.*

| Spearman correlation | TC | TG | HDL-C | LDL-C | VLDL |
|---|---|---|---|---|---|
| r (eGFR) | 0.188 | -0.019 | 0.008 | 0.036 | -0.108 |
| P value | 0.040* | 0.835 | 0.929 | 0.7 | 0.035* |
| Remark | Mild positive correlation and statistically significant | No correlation and statistically insignificant | No correlation and statistically insignificant | No correlation and statistically insignificant | Mild negative correlation and statistically significant |

As shown in the Table 6, based on the provided correlation coefficients and p-values, there is no strong evidence of a significant correlation between lipid profiles and blood urea in this dataset.

**Table 6.** *Correlation between lipid profiles with blood urea.*

| Spearman correlation | TC | TG | HDL-C | LDL-C | VLDL |
|---|---|---|---|---|---|
| r (Blood urea) | -0.108 | -0.009 | 0.058 | 0.132 | -0.103 |
| P value | 0.285 | 0.922 | 0.526 | 0.15 | 0.261 |
| Remark | Mild positive correlation and statistically significant | No correlation and statistically insignificant | No correlation and statistically insignificant | No correlation and statistically insignificant | Mild negative correlation and statistically significant |

As depicted in Table 7, the correlation coefficients (r values) reveal the intensity and direction of the association between Serum Creatinine (SER. CREAT) and different lipid profile elements there is no strong evidence to suggest a significant correlation between serum creatinine and the various lipid profile components.

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***Table 7.*** *Correlation between lipid profiles with SER. CREAT.*

| Spearman correlation | TC | TG | HDL-C | LDL-C | VLDL |
|---|---|---|---|---|---|
| r (SER. CREAT) | -0.137 | -0.036 | 0.107 | 0.106 | 0.101 |
| P value | 0.135 | 0.696 | 0.405 | 0.15 | 0.44 |
| Remark | Mild negative correlation and statistically insignificant | No correlation and statistically insignificant | Mild positive correlation and statistically insignificant | Mild positive correlation and statistically insignificant | Mild positive correlation and statistically insignificant |

## Discussion

DM stands out as the most prevalent metabolic disorder, with a notably high occurrence in India [8]. DN serves as a key indicator of microangiopathy and represents the primary contributor to renal failure among adults [4]. To date, there has been a limited number of studies addressing the specific type of nephropathy in T2DM in this region of India. Therefore, this study was undertaken to assess nephropathy by examining histopathological alterations in patients with T2DM.

We observed the levels of blood sugar in individuals diagnosed with diabetes after a fasting period of 2-3 hours. The overall results indicated an average blood sugar level of 175.92 ± 25.188 (ranging from 120 to 240). When categorized by gender, males exhibited an average of 175.18 ± 26.43 (ranging from 120 to 240), while females showed an average of 176.56± 24.25 (ranging from 120 to 234). In the overall analysis, the estimated Glomerular Filtration Rate (eGFR) exhibited a mean value of 84.28 ± 17.18 (ranging from 46 to 115.8). Upon gender-specific examination, males demonstrated a higher mean eGFR of 91.36 ± 15.09 (with a range of 53.2-115.8), whereas females exhibited a slightly lower mean eGFR of 78.09 ± 16.59 (ranging from 46 to 107.2). The results also indicated that there is a significant distinction between male and female eGFR values. This observation underscores the importance of considering gender-specific variations in kidney function, as reflected by eGFR measurements.

The results for serum creatinine levels demonstrate variations among the overall study population as well as between male and female subgroups. In the overall group, the mean serum creatinine level was 0.849 ± 0.169, ranging from 0.60 to 1.40. For males, the mean was slightly higher at 0.89 ± 0.167, with the same range of 0.60 to 1.40. In females, the mean was slightly lower at 0.813 ± 0.164, with a range of 0.6 to 1.2. There was statistically significant difference (p=0.017), indicating that there is a notable distinction in serum creatinine levels between the male and female groups. This finding suggests the importance of considering gender-specific differences when interpreting serum creatinine values in the context of the study. The association between lipid profile and fasting blood sugar levels was examined through Spearman correlation analysis. The results revealed a significant correlation (p=0.035*) between VLDL and fasting blood sugar. This suggests that fluctuations in VLDL levels are linked to alterations in fasting blood sugar levels, emphasizing a noteworthy relationship between these two variables. The association between the lipid profile and PPBS was examined using Spearman correlation analysis. The results showed a slight negative correlation between VLDL and PPBS, with a correlation coefficient (r) of -0.048 (p=0.599). The negative correlation suggests that as VLDL levels decrease, there is a tendency for PPBS to increase, and conversely, as VLDL levels increase, PPBS tends to decrease. However, it's important to note that this correlation was statistically insignificant, indicating that the observed relationship between VLDL and PPBS is not considered statistically significant. The p-values suggest a significant correlation between eGFR and TC as well as VLDL Cholesterol. However, other lipid profiles (TG, HDL-C, and LDL-C) do not exhibit significant correlations with eGFR. Regarding blood urea and lipid profiles, there is no strong evidence of a significant correlation. The correlation coefficients (r values) indicate the intensity and direction of the association between Serum Creatinine (SER. CREAT) and different lipid profile elements, suggesting no significant correlation between serum creatinine and the various lipid components.

According to Nayak, et al. the frequency of DN was found to be 32% in hospitalized patients. Another study conducted by Mani, et al. which involved 4837 patients with chronic renal failure over a 10-year period, reported a prevalence of DN at 30.3% in India [12,13]. Additional research has indicated varying prevalence rates, such as a study in Tamil Nadu by Mohan, et al. revealing a 24.3% prevalence of nephropathy [3]. In Bikaner, a separate study reported a prevalence of 30.2%. Furthermore, a cross-sectional study conducted in Lucknow in 2012 by Mohan, et al. demonstrated a 20% prevalence of DN [14].

Similarly, by Raja Reddy, et al., conducted a study in Karnataka, revealing that the occurrence of DN was documented at 37.02% [15]. The breakdown indicated that microalbuminuria affected 30.79% of males and 24.46% of females, while overt nephropathy was observed in 9.27% of males and 6.73% of females.

Another investigation conducted by Rudberg, et al., focused on adolescents with an average disease duration of 10.9 years, revealing that the duration of the disease played a significant role in determining the overall severity of glomerulopathy [16].

In the study done by Nayak, et al., the occurrence of DN was significantly linked to the duration of diabetes, HbA1c levels, serum urea, and HDL cholesterol ($p<0.05$ for each variable) [12]. A parallel investigation conducted by Mohan et al., employing regression analysis to assess risk factors, found a strong association between the duration of diabetes and HbA1c levels with the development of DN [14].

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According to the study done by Nayak, et al., the most prevalent renal abnormality observed histopathologically was DGS, present in 93.75% of cases, followed by NGS in 62.50%, membranous nephropathy in 12.5%, and focal necrotising glomerulonephritis in 6.25% [12]. Olsen, et al., on 33 biopsies revealed that 12.12% had Non-Diabetic Renal Diseases (NDRD), while the remaining 87.87% showed a distribution of 27.27% with DGS and 60.60% with NGS [17]. Another study conducted by Prakash, et al., reported a 12.3% prevalence of NDRD in diabetes, aligning with the findings of the present study [18]. In a study by Mathur, et al., it was demonstrated that 71.9% of cases with DN exhibited DGS, and 6.2% had a combination of DGS and NGS [19].

A study conducted by Schwartz, et al., found minimal distinctions in both clinical and biochemical factors among patients with these two forms of DN [20].

Blood urea and serum creatinine exhibited significant correlations with HbA1c, with p-values of 0.008 and 0.017, respectively. The kidneys play a crucial role in creatinine filtration, and elevated creatinine levels have been associated with the risk of renal failure, as noted by Mitchell, et al., and Zilva, et al. [21-23]. In the study conducted by Hamzah et al. in 2020, statistical analysis revealed a significant association between HbA1c levels and both serum creatinine ($p=0.017$) and serum cholesterol levels ($p<0.005$), as well as a highly significant correlation with blood urea levels ($p=0.008$). Additionally, a notable correlation ($p=0.035$) was found between serum TGRs and blood sugar levels. Unlike previous research on Type 2 Diabetes Mellitus (T2DM) that focused on renal function tests, lipid profiles, and liver function tests, our study introduced serum TGR as a novel parameter. Previous investigations primarily addressed general conditions, and findings align with those reported by Rajeswari, et al., and Al-Rubeaan, et al. [24,25].

Whereas, Manikandan, et al., reported that the average age of the participants in their study was 50.47 ± 14.32 years [26]. Female subjects exhibited higher levels of FBS and PPBS compared to their male counterparts, indicating suboptimal glycemic control and a potential risk for diabetic neuropathy and nephropathic complications. In contrast, female patients showed elevated TC, HDL, TGL, and VLDL values, whereas LDL levels were higher in male diabetic patients than in female diabetic patients. Although blood urea was slightly elevated in females compared to males, it remained within normal limits. Serum creatinine levels were similar between the male and female study participants.

## Conclusion

Our study investigated the lipid profiles and renal functions in individuals with T2DM at a tertiary care hospital. The findings contribute valuable insights into the relationship between lipid profiles and renal function in this specific diabetic population, shedding light on potential implications for patient care and management. Further research and clinical exploration are warranted to enhance our understanding of these associations and to develop more targeted interventions for individuals with T2DM.


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## Ethical Approval

The study received approval from the Institutional Ethical Committee at Shri B.M. Patil Medical College, Hospital, and Research Centre in Vijayapura, Karnataka, India, with the reference number BLDE(DU)/IEC/608/2022-23. Written informed consent was obtained for participation in the study and use of the patient data for research and educational purposes.


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## Conflict of Interest

There are no conflicts of interest.

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