Section: General Medicine

Original Research Article

STUDY OF CHRONIC INFLAMMATION IN TYPE 2 DIABETES MELLITUS AND IT'S CORRELATION WITH CONTROL STATUS AND COMPLICATIONS

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ABSTRACT

Background: Diabetes is a chronic, metabolic disease characterized by elevated levels of blood glucose, which leads over time to serious damage to the heart, blood vessels, eyes, kidneys and nerves, the most common is type 2 diabetes, usually in adults, which occurs when the body becomes resistant to insulin or doesn't make enough insulin. As type 2 Diabetes starts to develop, the body becomes less sensitive to insulin and the resulting insulin resistance also leads to inflammation. This study aimed to find out that, is there any significant degree of inflammation found with the subjects of Type 2 diabetes mellitus and is it correlating with control status and complications. The objective is to estimate the levels of chronic inflammatory parameters in subjects of Type 2 Diabetes Mellitus. B. To correlate the chronic inflammatory parameters with that of control status and complications of Type 2 Diabetes Mellitus.

Materials and Methods: A Cross sectional – observational study design to know the chronic inflammation in Type 2 Diabetes mellitus patients and its correlation with complications. 90 patients admitted with Type 2 Diabetes mellitus in K R Hospital, Mysore medical college and research institute from April 2023 – September 2024.

Results: In present study it was found that microalbuminuria is present in 67 individuals (74.4%), Hypertension in 50 individuals (55.6%), retinopathy is seen in 46 individuals (51.1%), nephropathy in 36 individuals (40%), IHD in 24 individuals (26.7%), CVA in 10 individuals (11.1%). The results show that individuals with microalbuminuria, HTN, retinopathy, nephropathy, IHD and CVA have significantly higher mean levels for ESR, CRP, LDH and S. Ferritin and lower levels of S. albumin which is significant and a p- value of 0.001.

Conclusion: This study provides impeccable evidence that, the chronic inflammation is associated with multiple complications in T2DM patients. Elevated chronic inflammatory markers are correlating with worsening kidney function, cardiovascular risks, and microvascular complications, emphasizing the need for inflammation-targeted therapeutic strategies to mitigate the long-term burden of diabetes-related complications.

Keywords: HTN, CVA, IHD, Chronic inflammation.

INTRODUCTION

Diabetes is a chronic, metabolic disease characterized by elevated levels of blood glucose, which leads over time to serious damage to the heart, blood vessels, eyes, kidneys and nerves, the most common is type 2 diabetes, usually in adults, which occurs when the body becomes resistant to insulin or doesn't make enough insulin.[1]

Prevalence of diabetes has been gradually increasing during the last few decades. International Diabetes Federation (IDF) estimates that nearly 500 million people worldwide are currently living with diabetes, a number that is projected to increase by a further

30% in 2045, a 1.5 million deaths are directly attributed to diabetes each year.[1]

This metabolic disease is indicated by high blood glucose levels due to insufficient insulin production by the pancreas, an inflammatory response occurs as a result of immune response to high blood glucose levels as well as the presence of inflammatory mediators produced by adipocytes and macrophages in fat tissue, this low and chronic inflammation damages the pancreatic beta cells and leads to insufficient insulin production, which results in hyperglycaemia.[2]

Diabetic complications namely cardiovascular diseases, neuropathy and nephropathy with subsequent amputation, usually leads to death.[3] As of now there were no studies comparing chronic inflammation in type 2 diabetes control status and complications. This study finds out that, is there any significant degree of inflammation found with the subjects of Type 2 diabetes mellitus and is it correlating with control status and complications.

MATERIALS AND METHODS

The current Cross-sectional study was conducted on 90 patients in OPD/ IPD of Medicine Department, KR Hospital, Mysore medical college and research institute from April 2023 – September 2024.

Inclusion Criteria

- Patients with Type 2 Diabetes mellitus with age >18 years

Exclusion Criteria

- Type 1 Diabetes mellitus patients
- Gestational Diabetes mellitus patients
- Patients with chronic liver disease
- Patients on steroids
- Infectious diseases
- Osteoarthritis
- Malignancy
- Autoimmune disease
- Patients on antimetabolites

Sample size calculation

Sample size: 90 cases (based on previous years statistics)

Sample size 90; s= (1.96 x 1.96 x .0627 x .9373)/ .05 x .05 = 90 per group; Z=std. value @ .05 level =1.96 P=proportion of prevalence =6.27% becomes .0627 Q=1-P = 1-0.0627 = .9373 D^2= Margin of error or confidence interval = 5% (to be expressed in decimals) = .05

Study Procedure: Patients with Type II Diabetes mellitus and passing selection criteria was taken into study, clinical examination was done in all of the study subjects. Blood sample was taken from each of theses individuals and following investigations were done: complete blood count(CBC). Renal function test (RFT). Liver function test (LFT), electrocardiogram (ECG), NCCT Head, serum electrolytes, 2 D Echocardiography, chest x ray, urine routine, USG abdomen Inflammatory markers ESR, CRP, FERRITIN LDH AND ALBUMUN were measured. The information was tallied and examination using the relevant statistical approach.

SPSS (Statistical Package for Social Sciences) version 21. (IBM SPASS statistics [IBM corporation: NY, USA]) was used to perform the statistical analysis. Data was entered in the excel spread sheet. Descriptive statistics of the explanatory and outcome variables were calculated by mean, standard deviation for quantitative variables, frequency and proportions for qualitative variables. Inferential statistics like Chi-square test was applied for qualitative variables to find the association. Independent sample t test was applied to compare the quantitative parameters between the groups. The level of significance is set at 5%.

RESULTS

[Table 1] presents the age distribution of 90 subjects, ranging from 37 to 88 years old, with a mean age of 57.78 years and a standard deviation of 11.92 years.

Table 1: Mean age distribution of subjects

	N	Minimum	Maximum	Mean	S.D.
Male	58	39.00	88.00	56.1379	11.33919
Female	32	37.00	83.00	60.7813	12.54857
Total	90	37.00	88.00	57.7889	11.92438

Table 2: Distribution of the subjects based on age groups

Age groups	Frequency	Percent
31-40 years	6	6.7
41-50 years	24	26.7
51-60 years	24	26.7
61-70 years	21	23.3
71-80 years	12	13.3
80+ years	3	3.3
Total	90	100.0

[Table 2] illustrates the distribution of 90 subjects across different age groups. The largest age group was 41 to 50 years and 51 to 60 years, each comprising 26.7% of the sample, followed closely by the 61 to 70 years group at 23.3%. The least represented groups were those aged 80 years and above, constituting 3% of the sample, and those aged 31 to 40 years, making up 6.7%.

Table 3: Distribution based on conditions

		Frequency	Percent
MICRO-ALBUMINURIA	Present	67	74.4
	Absent	23	25.6
HYPERTENSION	Present	50	55.6
	Absent	40	44.4
RETINOPATHY	Present	46	51.1
	Absent	44	48.9
NEPHROPATHY	Present	36	40
	Absent	54	60
IHD	Present	24	26.7
	Absent	66	73.3
CVA	Present	10	11.1
	Absent	80	88.9

The data presented in [Table 3] shows the distribution of various medical conditions among the participants. Microalbuminuria was absent in 23 individuals, making up 25.6% of the sample, while majority of the samples 67 individuals (74.4%) have microalbuminuria. Hypertension was absent in 40 participants (44.4%) and present in 50 participants (55.6%). Retinopathy changes were absent in 44 individuals (48.9%), while 46 individuals (51.1%) have retinopathy. Nephropathy was absent in 54 participants (60%) and 36 participants (40%) of participants have nephropathy. Ischaemic heart disease (IHD) was absent in 66 participants (73.3%), with 24 participants (26.7%) diagnosed with this condition. Cerebrovascular accident (CVA) had the highest rate of absence, with 80 individuals (88.9%) unaffected, and 10 individuals (11.1%) experiencing CVA.

Table 4: Comparison of the lab parameters based on serum creatinine levels using independent sample t test

Parameters	Microalbuminuria	N	Mean	Std. Deviation	Std. Error Mean	Mean difference	P value
S. Creatinine	Present	67	2.6146	2.32672	0.28425	1.35	0.008
	Absent	23	1.2683	0.73308	0.15286		
S. Ferritin	Present	67	305.96	372.74	45.54	178.61	0.025
	Absent	23	127.35	58.69	12.24		
S. Albumin	Present	67	3.281	0.61317	0.07491	-0.2	0.0213
	Absent	23	3.4787	0.75447	0.15732		
LDH	Present	67	276.61	196.11	23.96	108.0	0.013
	Absent	23	168.61	101.18	21.1		
ESR	Present	67	70.73	40.0	4.89	17.9	0.068
	Absent	23	52.83	40.51	8.45		
CRP	Present	67	29.15	37.03	4.52	18.89	0.018
	Absent	23	10.26	8.67	1.81		

The table compares lab parameters based on Microalbuminuria using an independent t-test. Serum Creatinine is significantly higher in individuals with Microalbuminuria (mean = 2.61, SD = 2.33) compared to those without (mean = 1.27, SD = 0.73), with a mean difference of 1.35 (p = 0.008, significant). Serum Ferritin is significantly elevated in the Microalbuminuria group (mean = 305.96, SD = 372.74) compared to the non-Microalbuminuria group (mean = 127.35, SD = 58.69), with a mean difference of 178.61 (p = 0.025, significant). LDH is significantly higher in those with Microalbuminuria (mean = 276.61, SD = 196.11) than those without (mean = 168.61, SD = 101.18), with a mean difference of 108.0 (p = 0.013, significant). CRP is significantly increased in Microalbuminuria patients (mean = 29.15, SD = 37.03) compared to non-Microalbuminuria patients (mean = 10.26, SD = 8.67), with a mean difference of 18.89 (p = 0.018, significant). ESR is higher in the Microalbuminuria group (mean = 70.73, SD = 40.00) compared to the non-Microalbuminuria group (mean = 52.83, SD = 40.51), with a mean difference of 17.9 (p = 0.068, not significant). Serum Albumin is significantly lower in individuals with Microalbuminuria (mean = 3.28, SD = 0.61) compared to those without (mean = 3.48, SD = 0.75), with a mean difference of -0.2 (p = 0.0213, significant).

Table 5: Comparison of the lab parameters based on hypertension using independent sample t test

Parameters	Hypertension	N	Mean	Std. Deviation	Std. Error Mean	Mean difference	P value
S. Creatinine	Present	50	2.6876	2.44954	.34642	.93831	0.036
	Absent	40	1.7493	1.48994	.23558		
S. Ferritin	Present	50	287.0400	358.02291	50.63209	60.14000	0.396
	Absent	40	226.9000	296.57825	46.89314		
S. Albumin	Present	50	3.2976	.68072	.09627	-.07640	.0.584
	Absent	40	3.3740	.62370	.09862		
LDH	Present	50	278.2600	217.09612	30.70203	65.81000	0.089
	Absent	40	212.4500	119.57166	18.90594		
ESR	Present	50	74.3600	39.79476	5.62783	18.46000	0.032
	Absent	40	55.9000	39.88175	6.30586		

CRP	Present	50	29.7600	41.74439	5.90355	12.23500	0.083
	Absent	40	17.5250	15.64836	2.47422		

This table presents a comparison of various serum parameters between individuals with and without hypertension:

Serum Creatinine is higher in hypertensive individuals (Mean = 2.6876) than non-hypertensive (Mean = 1.7493). The mean difference is 0.93831, with a P-value of 0.036, indicating statistical significance. Serum Ferritin is higher in hypertensive individuals (Mean = 287.04) than non-hypertensive (Mean = 226.90). Mean difference = 60.14, but P-value = 0.396, suggesting no significant difference. Serum Albumin is slightly lower in hypertensive individuals (Mean = 3.2976) compared to non-hypertensive (Mean = 3.3740). Mean difference = -0.0764, with a P-value of 0.584, indicating no significant difference. Lactate Dehydrogenase is higher in hypertensive individuals (Mean = 278.26) than non-hypertensive (Mean = 212.45). Mean difference = 65.81, with a P-value of 0.089, suggesting a trend but not statistically significant. Erythrocyte Sedimentation Rate is significantly higher in hypertensive individuals (Mean = 74.36) than non-hypertensive (Mean = 55.90). Mean difference = 18.46, with a P-value of 0.032, indicating statistical significance. C-Reactive Protein is higher in hypertensive individuals (Mean = 29.76) than non-hypertensive (Mean = 17.525). Mean difference = 12.235, with a P-value of 0.083, showing a trend but not statistically significant. Serum Creatinine and ESR showed statistically significant differences between hypertensive and non-hypertensive individuals. LDH and CRP showed trends toward higher values in hypertensive individuals but were not statistically significant. Serum Ferritin and Albumin did not show significant differences.

Table 6: Comparison of the lab parameters based on retinopathy using independent sample t test

Parameters	Retinopathy	N	Mean	Std. Deviation	Std. Error Mean	Mean difference	P value
S. Creatinine	Present	46	3.0123	2.41309	.35579	1.51721	0.000
	Absent	44	1.4951	1.41709	.21363		
S. Ferritin	Present	46	358.9130	424.97915	62.65976	201.68577	0.003
	Absent	44	157.2273	132.02270	19.90317		
S. Albumin	Present	46	3.2296	.62506	.09216	-.20862	0.131
	Absent	44	3.4382	.67248	.10138		
LDH	Present	46	296.3043	227.32853	33.51776	96.73617	0.011
	Absent	44	199.5682	99.68285	15.02775		
ESR	Present	46	86.9783	35.60555	5.24975	42.59190	0.00
	Absent	44	44.3864	33.87955	5.10753		
CRP	Present	46	32.0435	42.03594	6.19786	15.79348	0.023
	Absent	44	16.2500	17.47972	2.63517		

This table presents a comparison of various lab parameters based on the presence of Retinopathy, using an independent sample t-test.

Serum Creatinine is significantly higher in individuals with Retinopathy (mean = 3.01, SD = 2.41) compared to those without (mean = 1.50, SD = 1.42), with a mean difference of 1.52 (p = 0.000, significant). Serum Ferritin is significantly elevated in the Retinopathy group (mean = 358.91, SD = 424.98) compared to the non-Retinopathy group (mean = 157.23, SD = 132.02), with a mean difference of 201.69 (p = 0.003, significant). Serum Albumin is lower in individuals with Retinopathy (mean = 3.23, SD = 0.63) compared to those without (mean = 3.44, SD = 0.67), but the difference is not statistically significant (p = 0.131). LDH is significantly higher in the Retinopathy group (mean = 296.30, SD = 227.33) compared to those without (mean = 199.57, SD = 99.68), with a mean difference of 96.74 (p = 0.011, significant). ESR is markedly increased in individuals with Retinopathy (mean = 86.98, SD = 35.61) compared to those without (mean = 44.39, SD = 33.88), with a mean difference of 42.59 (p = 0.000, significant). CRP is significantly higher in individuals with Retinopathy (mean = 32.04, SD = 42.04) compared to those without (mean = 16.25, SD = 17.48), with a mean difference of 15.79 (p = 0.023, significant). Individuals with Retinopathy show significantly higher levels of Serum Creatinine, Ferritin, LDH, ESR, and CRP, indicating worsened kidney function, increased inflammation, and metabolic disturbances. Serum Albumin levels are lower but not statistically significant. These findings suggest that Retinopathy is strongly associated with systemic biochemical abnormalities.

Table 7: Comparison of the lab parameters based on nephropathy using independent sample t test

Parameters	Nephropathy	N	Mean	Std. Deviation	Std. Error Mean	Mean difference	P value
S. Creatinine	Present	36	3.5166	2.47234	.41206	2.07675	0.000
	Absent	54	1.4398	1.32507	.18032		
S. Ferritin	Present	36	334.6389	400.41301	66.73550	123.87963	0.083
	Absent	54	210.7593	269.47027	36.67026		
S. Albumin	Present	36	3.2264	.66867	.11144	-.17528	0.214
	Absent	54	3.4017	.63978	.08706		
LDH	Present	36	316.6944	233.26561	38.87760	112.80556	0.004

	Absent	54	203.8889	121.61921	16.55028		
ESR	Present	36	82.2778	38.86064	6.47677	26.87037	0.002
	Absent	54	55.4074	38.54697	5.24558		
CRP	Present	36	36.2778	46.60448	7.76741	19.92593	0.005
	Absent	54	16.3519	16.05904	2.18536		

This table presents a comparison of various lab parameters based on the presence of Nephropathy, using an independent sample t-test.

Serum Creatinine is significantly higher in individuals with Nephropathy (mean = 3.52, SD = 2.47) compared to those without (mean = 1.44, SD = 1.33), with a mean difference of 2.08 (p = 0.000, significant). Serum Ferritin is higher in the Nephropathy group (mean = 334.64, SD = 400.41) compared to the non-Nephropathy group (mean = 210.76, SD = 269.47), but the difference is not statistically significant (mean difference = 123.88, p = 0.083). Serum Albumin is lower in individuals with Nephropathy (mean = 3.23, SD = 0.67) compared to those without (mean = 3.40, SD = 0.64), but this difference is not statistically significant (mean difference = -0.18, p = 0.214). LDH is significantly higher in individuals with Nephropathy (mean = 316.69, SD = 233.27) compared to those without (mean = 203.89, SD = 121.62), with a mean difference of 112.81 (p = 0.004, significant). ESR is significantly elevated in the Nephropathy group (mean = 82.28, SD = 38.86) compared to those without (mean = 55.41, SD = 38.55), with a mean difference of 26.87 (p = 0.002, significant). CRP is significantly higher in individuals with Nephropathy (mean = 36.28, SD = 46.60) compared to those without (mean = 16.35, SD = 16.06), with a mean difference of 19.93 (p = 0.005, significant).

Table 8: Comparison of the lab parameters based on IHD using independent sample t test

Parameters	IHD	N	Mean	Std. Deviation	Std. Error Mean	Mean difference	P value
S. Creatinine	Present	24	3.3232	2.78813	.56912	1.43547	0.004
	Absent	66	1.8877	1.68748	.20771		
S. Ferritin	Present	24	431.5000	516.71799	105.47462	233.43939	0.003
	Absent	66	198.0606	203.49129	25.04805		
S. Albumin	Present	24	3.0346	.50603	.10329	-.40496	0.009
	Absent	66	3.4395	.67059	.08254		
LDH	Present	24	326.4583	246.96769	50.41207	105.60985	0.014
	Absent	66	220.8485	144.86633	17.83181		
ESR	Present	24	79.5417	39.09407	7.98004	18.25379	0.059
	Absent	66	61.2879	40.41811	4.97513		
CRP	Present	24	43.3750	53.70840	10.96318	25.98106	0.001
	Absent	66	17.3939	17.55771	2.16120		

This table presents a comparison of various lab parameters based on the presence of Ischaemic Heart Disease (IHD), using an independent sample t-test.

Serum Creatinine is significantly higher in individuals with IHD (mean = 3.32, SD = 2.79) compared to those without (mean = 1.89, SD = 1.69), with a mean difference of 1.44 (p = 0.004, significant). Serum Ferritin is significantly elevated in the IHD group (mean = 431.50, SD = 516.72) compared to the non-IHD group (mean = 198.06, SD = 203.49), with a mean difference of 233.44 (p = 0.003, significant). Serum Albumin is significantly lower in individuals with IHD (mean = 3.03, SD = 0.51) compared to those without (mean = 3.44, SD = 0.67), with a mean difference of -0.40 (p = 0.009, significant). LDH is significantly higher in the IHD group (mean = 326.46, SD = 246.97) compared to the non-IHD group (mean = 220.85, SD = 144.87), with a mean difference of 105.61 (p = 0.014, significant). ESR is higher in individuals with IHD (mean = 79.54, SD = 39.09) compared to those without (mean = 61.29, SD = 40.42), but this difference is not statistically significant (mean difference = 18.25, p = 0.059). CRP is significantly higher in individuals with IHD (mean = 43.38, SD = 53.71) compared to those without (mean = 17.39, SD = 17.56), with a mean difference of 25.98 (p = 0.001, significant).

Individuals with IHD show significantly higher levels of Serum Creatinine, Ferritin, LDH, and CRP, indicating worsened kidney function, increased inflammation, and altered metabolic status. Serum Albumin is significantly lower in IHD patients, suggesting possible nutritional or liver-related concerns. ESR shows a trend toward elevation but is not statistically significant.

Table 9: Comparison of the lab parameters based on CVA using independent sample t test

Parameters	CVA	N	Mean	Std. Deviation	Std. Error Mean	Mean difference	P value
S. Creatinine	Present	10	2.5807	1.76362	.55771	0.34894	0.626
	Absent	80	2.2318	2.16730	.24231		
S. Ferritin	Present	10	382.4000	381.47264	120.63224	137.35000	0.219
	Absent	80	245.0500	324.41222	36.27039		
S. Albumin	Present	10	2.9500	.44803	.14168	-.42925	0.050
	Absent	80	3.3792	.66143	.07395		
LDH	Present	10	428.6000	314.45056	99.43800	202.03750	0.001

	Absent	80	226.5625	147.14574	16.45139		
ESR	Present	10	79.4000	35.64080	11.27061	14.90000	0.277
	Absent	80	64.5000	41.15362	4.60111		
CRP	Present	10	25.7000	11.70043	3.70000	1.55000	0.890
	Absent	80	24.1500	35.04251	3.91787		

This table presents a comparison of various lab parameters based on the presence of Cerebrovascular Accident (CVA), using an independent sample t-test. Serum Creatinine is slightly higher in individuals with CVA (mean = 2.58, SD = 1.76) compared to those without (mean = 2.23, SD = 2.17), but the difference is not statistically significant (mean difference = 0.35, p = 0.626). Serum Ferritin is higher in the CVA group (mean = 382.40, SD = 381.47) compared to the non-CVA group (mean = 245.05, SD = 324.41), but this difference is not statistically significant (mean difference = 137.35, p = 0.219). Serum Albumin is lower in individuals with CVA (mean = 2.95, SD = 0.45) compared to those without (mean = 3.38, SD = 0.66), with a mean difference of -0.43 (p = 0.050, borderline significance). LDH is significantly higher in the CVA group (mean = 428.60, SD = 314.45) compared to the non-CVA group (mean = 226.56, SD = 147.15), with a mean difference of 202.04 (p = 0.001, significant). ESR is slightly elevated in individuals with CVA (mean = 79.40, SD = 35.64) compared to those without (mean = 64.50, SD = 41.15), but this difference is not statistically significant (mean difference = 14.90, p = 0.277). CRP levels are almost similar in both groups (mean = 25.70, SD = 11.70 in CVA group vs. mean = 24.15, SD = 35.04 in non-CVA group), with a mean difference of 1.55 (p = 0.890, not significant). Individuals with CVA show significantly higher LDH levels, indicating increased tissue damage (p = 0.001). Serum Albumin is lower with borderline significance (p = 0.050), while other parameters, including Serum Creatinine, Ferritin, ESR, and CRP, do not show statistically significant differences. These findings suggest that LDH may serve as a key marker in CVA patients.

DISCUSSION

This study aimed to assess the correlation between chronic inflammation and complications in patients with Type 2 Diabetes Mellitus (T2DM) and we found out that there is a significant correlation between inflammatory markers and various diabetes-related complications, reinforcing the role of chronic inflammation in the progression of diabetic complications.

The study included 90 subjects, predominantly male (64.4%), with a mean age of 57.78 years. The majority fell within the 41-50 and 51-60 age groups (26.7% each), it was correlated with study conducted by Deepa M et al,[4] indicating that T2DM prevalence increases with age and is more common in males in certain populations.

Our findings demonstrate that inflammatory markers, particularly CRP, ESR, and LDH, were elevated in patients with microalbuminuria, hypertension, retinopathy, nephropathy, ischemic heart disease (IHD), and cerebrovascular accident (CVA). These associations highlight the systemic inflammatory burden in diabetic individuals.

In our study microalbuminuria was present in 74.4% of patients, similar to study conducted by Navarro JF et al,[5] serum creatinine, a marker of renal dysfunction, was significantly higher in those with microalbuminuria (p = 0.008). Elevated CRP and LDH levels further support the role of inflammation in early kidney impairment. These findings are consistent with studies indicating that low-grade inflammation accelerates renal decline in diabetic nephropathy.

Hypertension was observed in 55.6% of patients. Serum creatinine and ESR were significantly elevated in hypertensive individuals (p = 0.036 and p = 0.032, respectively), suggesting an ongoing inflammatory response. Elevated inflammatory markers have been linked to endothelial dysfunction and increased arterial stiffness, contributing to hypertension in T2DM patients, similar to study conducted by Kampoli AM et al.[6]

Diabetic retinopathy was present in 51.1% of patients. Elevated serum creatinine, ferritin, and CRP levels ($p < 0.05$) suggest that inflammation plays a key role in the microvascular damage associated with retinopathy and chronic inflammation exacerbates retinal vascular permeability and oxidative stress, similar to study conducted by Gouliopoulos NS et al.[7]

Nephropathy was present in 40% of subjects. Significantly higher serum creatinine, LDH, ESR, and CRP levels ($p < 0.05$) reinforce the link between inflammation and kidney dysfunction. These results are in line with study conducted by Navarro-Gonzalez JF et al,[8] suggesting that inflammatory mediators like ESR, CRP and cytokines contribute to renal fibrosis and progressive kidney damage in diabetes.

IHD was found in 26.7% of patients, with significantly elevated serum creatinine, ferritin, LDH, and CRP levels ($p < 0.05$). These findings suggest that chronic inflammation contributes to atherosclerosis and cardiovascular complications in T2DM. In our study individuals with IHD show significantly higher levels Ferritin increased inflammation, and used as a early marker of cardiovascular risk similar to study conducted by Liu JR et al.[9]

CVA was observed in 11.1% of patients. While LDH levels were significantly higher (p = 0.001), suggest that inflammation plays a critical role in stroke pathogenesis in diabetic patients, contribute to endothelial dysfunction and cerebrovascular events

in diabetes, similar to study done by Yang DR et al.[10]

Our study underscores the role of chronic inflammation in the development of diabetic complications. Routine monitoring of inflammatory markers such as CRP, ESR, and LDH could aid in early identification and management of high-risk individuals. Future studies with larger sample sizes and longitudinal designs are needed to confirm these findings and explore potential therapeutic interventions targeting inflammation in T2DM.

CONCLUSION

This study provides impeccable evidence that, the chronic inflammation is associated with multiple complications in T2DM patients. Elevated chronic inflammatory markers are correlating with worsening kidney function, cardiovascular risks, and microvascular complications, emphasizing the need for inflammation-targeted therapeutic strategies to mitigate the long-term burden of diabetes-related complications.

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