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Original Article

Perspectives of Diabetes Mellitus on Vital Organ

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Abstract *- The study investigates the association between type 2 diabetes mellitus and liver function in 50 diabetic individuals compared to 30 controls, predominantly males. Liver function tests, including ALT, AST, ALP, serum albumin, and bilirubin, were conducted. Diabetic individuals were categorized into four grades based on fasting blood sugar levels. Compared to controls, diabetic individuals exhibited lower levels of total serum proteins, albumin, and albumin to globulin ratio, with grade IV diabetes showing particularly notable deviations, including low total serum proteins and albumin levels, alongside elevated thymol turbidity and alkaline phosphatase. However, individuals with lower-grade diabetes did not display significant alterations in liver function. This study underscores the importance of monitoring liver function, especially in advanced stages of type 2 diabetes, for timely intervention and management.*

Keywords *– Vital organ, Severity of diabetes, Liver function, Controlled diabetics, Uncontrolled diabetics.*

1. Introduction

Dating back to 1885, pioneering observations by Pavy highlighted a notable association between liver enlargement and diabetes mellitus, prompting speculation about a potential interplay between these two conditions. Subsequent to this, Soskin's research in 1934 brought focused attention to the liver's potential role in diabetes, particularly in its capacity to regulate blood glucose levels.

Diabetes mellitus, a complex metabolic disorder encompassing disturbances in carbohydrate, lipid, and protein metabolism, is characterized by chronically elevated blood sugar levels (hyperglycemia). Globally, the prevalence of diabetes has surged, affecting over 415 million individuals between the ages of 20 and 70, with projections indicating a staggering rise to 642 million by 2040. Particularly concerning is the epidemic proportions of diabetes in developing countries, where 75% of affected individuals reside, disproportionately impacting low- and middle-income nations.

A study conducted by Rohan Gupta et al. in 2021 delved into the correlation between liver dysfunction and long-standing diabetes mellitus as part of routine examinations in diabetic patients. The investigation focused on elucidating the relationship between long-standing diabetes mellitus and the presence of fatty acids in the liver. In a similar vein, Ayman S. Idris, in 2011, endeavored to assess liver function in patients with type 2 diabetes mellitus, utilizing markers such as aspartate aminotransferase, alanine aminotransferase (ALT), gamma-glutamyl transpeptidase (GGT), and total protein levels to elucidate the status of hepatic function.

Moreover, a body of research spanning several decades, including studies by Stillerman (1948), Zimmermann et al. (1950), Sharma et al. (1962), and Mather et al. (1965), has consistently demonstrated evidence of hepatic dysfunction in individuals with diabetes. These studies have unveiled statistically significant impairments in crucial biomarkers such as human albumin levels, albumin-to-globulin ratios, serum alkaline phosphatase, and flocculation tests.

However, despite the accumulation of evidence, the intricate interplay between hepatic dysfunction and aberrations in glycemic control remains a challenging conundrum. It remains uncertain whether hepatic dysfunction disrupts the finely tuned regulatory mechanisms of the liver in controlling blood glucose levels, thereby contributing to abnormalities in glycemia, or if fluctuations in diabetic control precipitate disturbances in hepatic function.

Further research is warranted to unravel the complex dynamics underlying this relationship, paving the way for enhanced therapeutic strategies and targeted interventions in the management of diabetes mellitus and associated hepatic complications.

2. Material and Methods

A comparative cross-sectional study was conducted at Apollo Diagnostic Centre, Jaunpur, involving 50 diabetic and 30 non-diabetic individuals throughout the year 2023. Diabetic participants aged 20-70 underwent a battery of Liver Function Tests (LFT), including ALT and AST, ALP, serum albumin, and bilirubin, utilizing ELISA and a ready-made kit from a reputable company at Apollo Diagnostic Centre.

The severity of diabetes was categorized based on the grading system established by Frankel et al. in 1950, delineated as follows:

- Grade I: Fasting blood sugar level up to 200 mg/dl
- Grade II: Fasting blood sugar levels between 201 and 300 mg/dl
- Grade III: Fasting blood sugar level of 300 mg/dl or higher
- Grade IV: Diabetes with ketosis

Among diabetic individuals, the lower end of the range for total serum protein, albumin, albumin-to-globulin ratio, and serum alkaline phosphatase fell below the corresponding figures observed in the control group. Conversely, the upper range of serum globulin and thymol turbidity was higher compared to controls. Efforts were made to explore potential correlations between these liver function test values and factors such as age, sex, and duration of disease. However, no significant impact on hepatic dysfunction was discerned.

However, upon delving deeper into the data and considering the weight of the patients, notable trends emerged. Levels of proteins, albumin, and the albumin-to-globulin ratio were observed to be lower in obese cases compared to those of average weight, with the lowest levels detected in individuals with a thin build. Conversely, the levels of serum bilirubin, globulin, thymol turbidity, and thymol flocculation were higher in obese patients, exhibiting the highest levels in severely obese diabetics compared to those of average weight.

3. Observation

This study enrolled 50 individuals diagnosed with diabetes mellitus who exhibited no apparent clinical signs of liver disease, along with 30 matched controls, for the purpose of conducting a comparative analysis. Participants' ages ranged from 20 to 70 years, with the majority falling within the 40-60 year age range. Notably, there was a higher proportion of male participants compared to female participants in both groups.

Table 1 below presents the average values for various liver function tests among diabetic patients and normal controls. In the diabetic group, the average values for total serum proteins, albumin, and albumin-to-globulin ratio were observed to be lower compared to the control group, whereas the average values for serum globulin, thymol turbidity, and alkaline phosphatase were higher. Furthermore, the range of values for these tests was wider in the diabetic group, indicating greater variability within this population.

Table 1. The average values for various liver function tests

Liver Function Test	Diabetic Patients (50 cases)		Controls (30 cases)	
	Mean	Range	Mean	Range
Total serum protein (gm %)	6.48	3.9 - 7.63	6.75	6.12 - 7.60
Serum albumin (gm %)	3.97	1.36 - 5.24	4.62	3.74 - 5.64
Serum globulin (gm %)	2.52	1.70 - 3.46	2.12	1.52 - 2.82
Albumin globulin ratio	1.55	0.76 - 2.67	2.17	1.40 - 3.66
Serum bilirubin (mg %)	0.60	0.33 - 2.30	0.73	0.34 - 1.10
Thymol turbidity (units/ml)	3.36	1 - 9	2.80	1 - 4
Thymol flocculation at 18 hours	-	0 - 3	-	0 - 1
Serum alkaline phosphatase (K.A. units)	10.14	4 - 18.6	9.17	6.60 - 14.7

Table 2. Liver function among individuals with grade IV diabetes

Liver Function Test	Severity of Diabetes			
	Grade I 28 Cases	Grade II 11 cases	Grade III 5 cases	Grade IV 6 cases
Total serum protein (gm %)	6.516	6.922	6.918	5.216
Serum albumin (gm %)	4.087	4.247	4.666	2.388
Serum globulin (gm %)	2.432	2.675	2.252	2.828
Albumin/globulin ratio	1.680	1.587	2.094	0.845
Thymol turbidity (units)	2.536	3.090	3.000	7.166
Serum bilirubin (mg %)	0.620	0.684	0.636	0.955
Thymol flocculation	0 (17 cases) 1 (8 cases) 2 (3 cases)	0 (10 cases) 1 (1 case)	0 (2 cases) 1 (3 cases)	1 (4 cases) 2 (1 case) 3 (1 case)
Serum alkaline phosphatase	9.268	10.318	8.540	15.250

Table 3. Controlled and Uncontrolled diabetics for liver function test

Liver Function Test	Controlled Diabetics (17 cases)	Uncontrolled Diabetics (33 cases)
Total serum protein (gm %)	6.657	6.406
Serum albumin (gm %)	4.204	3.859
Serum globulin (gm %)	2.453	2.547
Albumin/globulin ratio	1.709	1.574
Thymol turbidity (units)	2.059	3.878
Thymol flocculation	0 (12 cases) 1 (4 cases) 2 (1 case)	0 (17 cases) 1 (12 cases) 3 (1 case)
Serum bilirubin (mg %)	0.538	0.750
Serum alkaline phosphatase	8.917	10.776

The data presented in the above tables indicates a notable deterioration in liver function among individuals with grade IV diabetes, characterized by lower levels of serum proteins and albumin-to-globulin ratio, as well as elevated serum alkaline phosphatase and thymol turbidity. Moreover, a higher incidence of abnormal thymol flocculation was observed in grade IV diabetics.

Conversely, individuals with grade I, II, and III diabetes did not exhibit significant alterations in liver function. To further elucidate these findings, diabetic subjects were subdivided into two overarching groups based on the control of their diabetes.

It is evident that individuals with uncontrolled diabetes displayed lower levels of total serum protein and serum albumin. Additionally, the incidence of abnormal thymol flocculation was relatively higher in the uncontrolled diabetes group compared to the controlled group. These findings suggest a correlation between the control of diabetes and liver function, underscoring the importance of glycemic control in mitigating liver dysfunction associated with diabetes.

4. Discussion

There are numerous speculations and hypotheses surrounding the state and function of the liver, not only in diabetes mellitus but also in various metabolic disorders due to the liver's multitude of functions. It's tempting to speculate that, in certain instances, liver cirrhosis might lead to a permanent syndrome resembling diabetes, but conclusive evidence requires comprehensive research. Despite numerous reports on the liver's status in diabetes, there remains a lack of consensus among researchers regarding the nature and extent of liver function impairment in diabetic individuals.

The uncertainty surrounding the liver's status in diabetes motivated our study to shed light on some aspects of the liver in individuals with diabetes. Our findings among diabetic patients indicated impaired liver function tests compared to those in non-diabetic controls. Specifically, mean values for total serum protein, albumin, and albumin-to-globulin ratio were lower, while thymol turbidity and alkaline phosphatase levels were higher in diabetic individuals compared to controls.

Our results align with findings from other studies, where alkaline phosphatase was consistently highlighted as the most commonly elevated liver enzyme in diabetic patients. Notably, studies by Kocabey et al. (2011) and Bora et al. (2016) reported similar observations, with alkaline phosphatase values being the most common abnormality observed. Conversely, abnormalities in total protein were reported as the least common. These findings are in line with earlier research by G. Siest et al. (1973).

Furthermore, when considering the severity of diabetes and hepatic dysfunction, we observed more pronounced impaired hepatic function tests in grade IV diabetic patients, characterized by notably low total serum protein and albumin levels, and significantly elevated thymol turbidity, thymol flocculation, and serum alkaline phosphatase levels. However, individuals with grade I, II, and III diabetes did not exhibit significant alterations in liver functions.

Our findings corroborate previous studies conducted by H. Yamazaki et al. (2013), K.C. Sung (2013), M Shibata et al. (2007), and Li W. D. et al. (2015), which also found no significant degree of alteration in liver functions among individuals with less severe grades of diabetes, and with Aditya C. et al., (2023) who found that long-standing or chronic diabetes due to its multisystem affection can adversely affect liver functions.

5. Conclusion

The present study reveals an increased risk of liver function test (LFT) abnormalities in individuals with grade IV diabetes compared to non-diabetic individuals. Specifically, those with grade IV diabetes exhibited lower serum protein levels and a reduced albumin-to-globulin ratio, alongside elevated serum alkaline phosphatase and thymol turbidity levels.

In contrast, individuals with grade I, II, and III diabetes did not show any significant changes in liver function. These findings highlight a correlation between uncontrolled diabetes and liver dysfunction. Given that the liver is the primary organ for metabolism, uncontrolled glycemic levels can lead to liver impairment. Therefore, individuals with grade IV diabetes should undergo regular LFT screening. Additionally, routine LFT monitoring is recommended for diabetic patients presenting with ketosis.

References

[1] Aditya Chilay et al., "Liver Function Test and Diabetes Mellitus: Correlation from a Laboratory Perspective," *Indian Journal of Medical Biochemistry*, vol. 27, no. 2, pp. 40-44, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[2] Ayman S. Idris et al., "Liver Function Tests in Type 2 Sudanese Diabetic Patients," *International Journal of Nutrition and Metabolism*, vol. 3, no. 2, pp. 17-21, 2011. [CrossRef] [Google Scholar] [Publisher Link]

[3] Rohan Gupta et al., "Study of Liver Function Tests in Patients with Long Standing Type 2 Diabetes Mellitus in Comparison to Healthy Individuals," *Journal of Evaluation of Medical and Dental Science*, vol. 10, no. 5, pp. 289-293, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[4] Jamaludin Mahamed et al., "Mechanisms of Diabetes-Induced Liver Damage: The Role of Oxidative Stress and Inflammation," *Sultan Qaboos University Medical Journal*, vol. 16, no. 2, pp. 132-141, 2016. [CrossRef] [Google Scholar] [Publisher Link]

[5] Keith G. Tolman et al., "Spectrum of Liver Disease in Type 2 Diabetes and Management of Patients With Diabetes and Liver Disease," *Diabetes Care*, vol. 30, no. 3, pp. 734-743, 2007. [CrossRef] [Google Scholar] [Publisher Link]

[6] Ajita Acharya et al., "Diabetes and Liver an Association: Hepatogenous Diabetes Mechanism and Some Evidences," *Journal of Cell Science & Therapy*, vol. 7, no. 6, pp. 1-6, 2016. [Google Scholar] [Publisher Link]

[7] Gérard Siest et al., "Aspartate Aminotransferase and Alanine Aminotransferase Activities in Plasma: Statistical Distributions, Individual Variations, and Reference Values," *Clinical Chemistry*, vol. 21, no. 8, pp. 1077-1087, 1975. [CrossRef] [Google Scholar] [Publisher Link]

[8] Kaustubh Bora et al., "Presence of Concurrent Derangements of Liver Function Tests in Type 2 Diabetes and Their Relationship with Glycemic Status: A Retrospective Observational Study from Meghalaya," *Journal of Laboratory Physicians*, vol. 8, no. 1, pp. 30-35, 2016. [CrossRef] [Google Scholar] [Publisher Link]

[9] Hajime Yamazaki et al., "Independent Association Between Improvement of Nonalcoholic Fatty Liver Disease and Reduced Incidence of Type 2 Diabetes," *Diabetes Care*, vol. 38, no. 9, pp. 1673-1679, 2015. [CrossRef] [Google Scholar] [Publisher Link]

[10] Ki-Chul Sung et al., "Combined Influence of Insulin Resistance, Overweight/Obesity, and Fatty Liver as Risk Factors for Type 2 Diabetes," *Diabetes Care*, vol. 35, no. 4, pp. 717-722, 2012. [CrossRef] [Google Scholar] [Publisher Link]

[11] Ki-Chul Sung, Sarah H. Wild, and Christopher D. Byrne, "Resolution of Fatty Liver and Risk of Incident Diabetes," *Journal of Clinical Endocrinology & Metabolism*, vol. 98, no. 9, pp. 3637-3643, 2013. [CrossRef] [Google Scholar] [Publisher Link]

[12] Michihiko Shibata et al., "Nonalcoholic Fatty Liver Disease Is a Risk Factor for Type 2 Diabetes in Middle-Aged Japanese Men," *Diabetes Care*, vol. 30, no. 11, pp. 2940-2944, 2007. [CrossRef] [Google Scholar] [Publisher Link]

[13] Wei-Dong Li et al., "Comparison of Effects of Obesity and Non-Alcoholic Fatty Liver Disease on Incidence of Type 2 Diabetes Mellitus," *World Journal of Gastroenterology*, vol. 21, no. 32, pp. 9607-9613, 2015. [CrossRef] [Google Scholar] [Publisher Link]

[14] C.-H. Kim et al., "Fatty Liver is an Independent Risk Factor for the Development of Type 2 Diabetes in Korean Adults," *Diabetic Medicine*, vol. 25, no. 4, pp. 476-481, 2008. [CrossRef] [Google Scholar] [Publisher Link]

[15] Anuradhani Kasturiratne et al., "Influence of Non-Alcoholic Fatty Liver Disease on the Development of Diabetes Mellitus," *Journal of Gastroenterology and Hepatology*, vol. 28, no. 1, pp. 142-147, 2013. [CrossRef] [Google Scholar] [Publisher Link]

[16] Sasiwarang Goya Wannamethee et al., "Hepatic Enzymes, the Metabolic Syndrome, and the Risk of Type 2 Diabetes in Older Men," *Diabetes Care*, vol. 28, no. 12, pp. 2913-2918, 2005. [CrossRef] [Google Scholar] [Publisher Link]