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Disturbed Metabolism and Its Effect on Liver Function in Adults

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Abstract

General Background: The liver plays an essential role in lipid metabolism, detoxification, and maintaining metabolic homeostasis. **Specific Background:** Disturbances in lipid metabolism may contribute to hepatic cellular stress, oxidative damage, and alterations in liver enzyme activity. **Knowledge Gap:** Further characterization of the relationship between lipid abnormalities and biochemical markers of liver function is needed to understand metabolic disturbances in adults. **Aims:** This study aimed to examine the relationship between metabolic disorders, lipid profile parameters, and hepatic enzyme levels in adults aged over 40 years. **Results:** This cross-sectional study involved 60 participants divided into normal metabolic profile and metabolic disturbance groups, with 30 participants in each group. The metabolic disturbance group demonstrated higher mean ALT (45.8 ± 8.3 U/L), AST (41.6 ± 7.9 U/L), and GGT (36.9 ± 6.5 U/L) levels than the normal metabolic profile group. Total cholesterol, triglycerides, LDL, and VLDL were also higher, whereas HDL was lower. Positive correlations were observed between total cholesterol, triglycerides, and LDL and hepatic enzyme levels, while HDL demonstrated negative correlations. **Novelty:** The study provides a combined assessment of lipid profile parameters and three hepatic enzyme markers across two metabolic groups of adults. **Implications:** Concurrent evaluation of lipid profiles and liver enzymes may support the early identification of metabolic abnormalities associated with altered liver function.

Highlights:

- ALT and AST levels were approximately twice as high in the metabolic disturbance group.
- HDL concentrations were lower among participants with metabolic abnormalities.
- Triglycerides showed positive correlations with ALT, AST, and GGT.

Keywords: Lipid metabolism, Hepatic enzymes, Liver function, Dyslipidemia, Metabolic disorders

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Introduction

The liver is recognized as being the chief site of metabolism in the human body. In relation to the function of the organ, it plays an essential role in maintaining the balance within the whole body system. Some of the physiological roles performed by the liver include the elimination of toxic substances from the body, protein synthesis, bile production, and the regulation of carbohydrates and fats (Hall & Hall, 2021; Rui, 2014). As a result of the metabolic processes that take place within the liver, it becomes more prone to cellular stress.

In all these processes of the liver, the most crucial function performed by liver cells could be described as the regulation of lipid homeostasis. Under physiological conditions, liver cells play the role of regulating different stages of lipogenesis, lipid metabolism, and beta-oxidation (Friedman et al., 2018; Nguyen et al., 2008). However, when such processes are no longer regulated properly, the accumulation of free fatty acids and triglycerides takes place inside liver cells, resulting in different metabolic problems.

In the past ten years, this kind of lipid metabolism has emerged as one of the primary causes of the occurrence of metabolic liver diseases across the globe. Lipid and triglyceride overload will end up with the ectopic accumulation of lipids inside the cells of the liver, causing the failure in the proper functioning of the liver (Younossi et al., 2019; Ipsen et al., 2018). If this continues unchecked, there will be yet another generation of inflammatory oxidative stress.

But when it comes to the clinical diagnosis of the severity of the cell damage that occurs in the liver, serum biochemical indicators prove to be the most useful method for making a diagnosis. First and foremost, increased ALT and AST indicators become a clear marker of the liver dysfunction because they reflect the leakages of these enzymes from hepatocytes and metabolic disorders occurring within them (Schuppan & Afdhal, 2008; Pratt & Kaplan, 2000). Besides, there is one more marker that plays an essential role in the diagnosis of the disease, and this one is the GGT indicator, which indicates the occurrence of both functional disorders and oxidative stress (Whitfield, 2001; Espinosa-Diez et al., 2015).

Epidemiologic studies suggest that the incidence of metabolic liver disease in the world population has been on the rise at an alarming rate in recent years. These conditions, if not properly diagnosed or treated, can result in a further progression of disease stages including liver fibrosis, cirrhosis, and ultimately hepatocellular carcinoma (Younossi et al., 2016). As such, it is highly essential for clinicians to be familiar with the mechanisms underlying metabolic disorders in order to better diagnose and treat the patients. Metabolic liver disorders and liver enzymes will thus be examined in detail in this study.

Materials and Methods

Study Design

The present study was conducted in the form of a cross-sectional study which was intended to investigate the relationship between metabolic disorders and markers of liver functions in adult individuals.

Subjects of Study

For this study, adult patients aged above 40 years were selected. Patients with any previous history of chronic liver disease or viral hepatitis, as well as any other systemic disorder, were excluded from the study as they can act as confounding factors.

The selected subjects were categorized on the basis of their biochemical data as follows:

Group I: Subjects without metabolic disorders

Group II: Subjects with metabolic disorders

Sample Collection

The venous blood was collected from each participant after having abstained from eating overnight for 8-12 hours. These blood samples were drawn under sterilized conditions and immediately analyzed in the laboratory. Serums were extracted through centrifugation and kept frozen until analyses were conducted.

Laboratory Analyses

Biochemical analyses focused on several parameters concerning metabolism and functions of the liver. Lipid metabolism was assessed through the levels of total cholesterol, triglycerides, LDL, VLDL, and HDL. Liver functions were assessed based on the following standard markers:

A.ALT

B.AST

C.GGT

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Biochemical tests were conducted under laboratory settings utilizing spectrophotometric automatic analyzers.

Statistical Analysis

All data collected in the laboratory setting were analyzed using statistical methods. Quantitative measures were presented in terms of mean ± SD. The analysis of difference between two groups was based on an adequate statistical procedure. Significance level of 0.05 was considered statistically significant.

Results

Biochemical analysis conducted during this experiment showed significant variations in the activities of liver enzymes and metabolism of lipids among adult participants of this research study. The information obtained is very helpful for better understanding of the relationship between metabolic disorders and functioning of the liver.

The individuals that were identified to have metabolic disorders had notable differences in the activities of liver enzymes from individuals that were identified as having no metabolic disorder. For example, there was a notable increase in ALT and AST enzyme levels among individuals that had abnormal levels of lipid levels.

As for other enzymes, levels of gamma-glutamyl transferase (GGT) were significantly higher in individuals with the presence of high lipid concentration. GGT enzyme is related to oxidative stress and abnormality of hepatobiliary functions in the liver. In this case, the increase of the GGT level may be seen as an indicator of changes occurring in the process of hepatic detoxification.

Metabolic analysis revealed a significant imbalance among individuals with metabolic disorders. In this connection, it should be noted that there were higher levels of total cholesterol, triglycerides, LDL, and VLDL in individuals with metabolic imbalance. As for other enzymes, levels of gamma-glutamyl transferase (GGT) were significantly higher in individuals with the presence of high lipid concentration. GGT enzyme is related to oxidative stress and abnormality of hepatobiliary functions in the liver. In this case, the increase of the GGT level may be seen as an indicator of changes occurring in the process of hepatic detoxification.

Metabolic analysis revealed a significant imbalance among individuals with metabolic disorders. In this connection, it should be noted that there were higher levels of total cholesterol, triglycerides, LDL, and VLDL in individuals with metabolic imbalance.

On the other hand, high density lipoproteins (HDLs) were observed to be lowered in patients suffering from metabolic imbalances. The importance of high density lipoprotein lies in its role in reverse cholesterol transport. Inadequate HDL levels may impair lipid removal from the liver, hence resulting in the deposition of lipids within the liver cells.

From the above discussion, it is clear that a relationship exists between metabolic imbalances and enzyme activities in the liver.

Table (1): Enzymatic Activity in Livers of Study Subjects.

Parameter	Normal Metabolic Profile (n=30)	Metabolic Disturbance (n=30)	Reference Range	P-value
ALT (U/L)	22.4 ± 5.1	45.8 ± 8.3	7 – 40	<0.01
AST (U/L)	20.1 ± 4.7	41.6 ± 7.9	8 – 40	<0.01
GGT (U/L)	18.5 ± 4.3	36.9 ± 6.5	9 – 48	<0.01

The following figures presented in Table (1) reveal clearly that there is an increase in the activities of liver enzymes amongst patients of metabolic diseases. This indicates that the ALT and AST levels are almost twice that of patients free from any type of metabolic disease; hence there is stress on liver cells.

Table (2): Lipid Profile Indices in Study Groups.

Parameter	Normal Metabolic Profile (n=30)	Metabolic Disturbance (n=30)	Reference Range	P-value
Total Cholesterol (mg/dL)	168.3 ± 22.5	236.7 ± 34.1	<200	<0.01
Triglycerides (mg/dL)	112.4 ± 18.7	208.5 ± 41.3	<150	<0.01
LDL (mg/dL)	98.6 ± 16.4	158.2 ± 28.7	<130	<0.01
HDL (mg/dL)	52.1 ± 6.5	38.4 ± 5.9	<40	<0.01
VLDL (mg/dL)	22.5 ± 4.3	41.7 ± 7.8	5 – 40	<0.01

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As depicted in Table 2, patients with metabolic disorders had an extremely disrupted lipid profile. The levels of total cholesterol, triglycerides, LDL, and VLDL were much higher, while the HDL level was much lower than in healthy individuals.

Table (3): Relationship between Lipid Profile and Liver Enzymes.

Lipid Parameter	ALT (r)	AST (r)	GGT (r)
Total Cholesterol	0.52	0.48	0.55
Triglycerides	0.57	0.49	0.60
LDL	0.50	0.45	0.54
HDL	-0.41	-0.38	-0.36

The table 3 shows the correlation between the parameters of lipid metabolism and the activity of liver enzymes. The fact that there was a positive correlation between cholesterol, triglycerides, LDL, and the activity of liver enzymes could indicate a potential increase in stress in hepatocytes due to an increased level of lipids. On the other hand, the concentration of HDL had a negative correlation with the activity of liver enzymes, showing its protective properties.

To summarize, the results of this investigation have proved that metabolic diseases correlate strongly with changes in the activity of liver enzymes. Thus, the increase in the concentration of lipids is connected with the growth of stress and oxidative damage in hepatocytes.

One may state that disorders in lipid metabolism can be recognized as one of the significant factors affecting metabolic dysfunction of the liver.

Discussion

The results of this study demonstrate clearly the complexity of association of metabolic disorders with enzyme activities in the liver in adults. In particular, this study emphasizes the significant influence that abnormalities in lipid metabolism can have on laboratory tests for clinical biochemistry. It is obvious from the very high correlation between abnormal lipid levels and higher levels of hepatic enzymes that metabolic abnormalities at an early stage lead to the onset of subclinical liver dysfunction.

Hepatic Lipid Homeostasis and Pathophysiological Mechanisms

It should be noted that the liver has a critical role to play in keeping the balance of fats in the body system since it has the capability of regulating the balance between the oxidation of fatty acids, de novo production of triglycerides, and lipoprotein secretion (Friedman et al., 2018; Rui, 2014). At physiological levels, there is a strict balance maintained by hepatocytes between the influx of lipids from circulation, their metabolism, or their efflux. On the contrary, an increase in plasma lipid components, specifically triglycerides and LDL, causes a breakdown in this regulation system, resulting in lipotoxicity.

Interpretation of Transaminase Dynamics

Following the pathophysiology described above, the metabolic dysfunction group in the current study demonstrated statistically significant elevations in levels of both alanine aminotransferase (ALT) and aspartate aminotransferase (AST) when compared to their metabolically normal counterparts. While ALT is primarily concentrated in the cytoplasm of hepatocytes, it continues to serve as the most precise indicator of acute or chronic parenchymal damage (Pratt & Kaplan, 2000). In cases where prolonged metabolic stress is present, membrane integrity becomes compromised and results in increased intracellular ALT spillover into the bloodstream (Senior, 2012). Although AST is not as organ-specific as ALT owing to its location in cardiac and skeletal muscles, AST is elevated and thus indicates an additional factor – accelerated hepatocellular necrosis (Ghouri et al., 2010).

GGT Activity and Cellular Oxidative Stress

Aside from variations in transaminase enzyme activities, a significant rise in the activity of the gamma-glutamyl transferase (GGT) enzyme in metabolically stressed animals is also another defining characteristic of metabolic stress occurring in specific target cells. The primary function of GGT in the body is that of the degradation of glutathione in the extracellular environment and as such can be considered an important defense enzyme against oxidative damage (Whitfield, 2001). Increased concentrations of serum GGT are often seen in diseases affecting the liver/biliary system, fat tissue buildup, and insulin resistance (Kunutsor, 2016).

The Dual Role of Oxidative Stress and Chronic Inflammation

Oxidative stress is an important link mechanism connecting metabolic syndrome and actual damage to the liver. The high burden on the electron transport chain within mitochondria causes an overproduction of ROS, which leads to lipid peroxidation of mitochondrial membranes, denaturation of proteins, and DNA damage (Tilg & Moschen, 2010). This process of oxidative stress hinders the function of mitochondrial beta-oxidation, causing a vicious circle of accumulation of lipids (Mansouri et al., 2018).
In addition to this, the lipotoxic state creates a scenario for the development of inflammation in the liver. The presence of saturated fatty acids in the liver leads to secretion of pro-inflammatory cytokines such as TNF-α and IL-6, which further lead to

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recruitment of circulating immune cells to the liver tissue (Cusi, 2012). Chronic exposure to these inflammatory signals results in activation of HSCs (quiescent cells), which transform into myofibroblast-like cells that produce extracellular matrix proteins causing liver fibrosis (Schuppan & Afdhal, 2008).

Dyslipidemia and Reverse Cholesterol Transport

The second important observation noted in this study involved the marked decrease in HDL cholesterol among the metabolically dysfunctional group. HDL acts as the chief mediator in reverse cholesterol transport, a mechanism highly effective in clearing free cholesterol by scavenging it from other bodily tissues and macrophages and delivering it back to the liver for biliary clearance (Rosenson et al., 2012). Deficient HDL directly impedes this clearance process, leading to increased cholesterol entrapment in the hepatocyte and worsening metabolic dysfunction in the liver, contributing to lipotoxicity (Younossi et al., 2019).

Clinical Implications and Study Limitations

As a whole, the findings from this study clearly correlate with the body of evidence in the literature concerning the relationship between dyslipidemia and liver enzyme changes (Friedman et al., 2018; Younossi et al., 2019). In terms of practice and preventive medicine, this evidence highlights the importance of routinely performing opportunistic tests for metabolic abnormalities and/or lipid disorders among adults. By evaluating lipid profiles and transaminase levels at the same time, doctors are able to diagnose metabolic liver problems at an early stage when structural damage does not exist yet. Early changes in diet and metabolic corrections can efficiently prevent the progression of liver steatosis (Wong et al., 2016).

Nevertheless, some limitations need to be considered in relation to this study:

•Sample Size: The sample size of this research was small, which makes the results less generalizable to other, broader demographic populations. Further multicenter studies with bigger cohorts should be conducted.

•Research Design: Because of the design of this cross-sectional research, it is impossible to draw any conclusions about the causal connections between the metabolic factors and hepatic enzyme function. Prospective and longitudinal studies are needed in order to identify the exact chronological sequence of events in the metabolic process (Targher et al., 2010).

In summary, this study has made an important contribution to the scientific community regarding metabolic disorders. The study proves that there is a strong effect of metabolic disturbances, especially those linked with fat metabolism, on the development of liver dysfunction.

Conclusion

From this experiment, it can be clearly stated that there is a strong relationship between metabolic disorders and the change in enzyme level in the liver of adults. Elevated level of lipids can put pressure on the liver cells, and hence, there will be a rise in ALT, AST, and GGT level in blood.

This study clearly indicates that maintaining metabolic stability is essential for maintaining healthy liver function. Biochemical tests are a good indicator of the early stage of metabolic disorders, and hence, any further liver disease can be prevented.Further research in this direction is recommended.

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