Assessment of thermogravimetric properties of the gallbladder using B-mode grey scale ultrasonography in diabetic patients with neuropathy

Evaluación de las propiedades termogravimétricas de la vesícula biliar mediante ecografía en escala de grises en modo B en pacientes diabéticos con neuropatía

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Abstract

Background: The prevalent symptom of diabetes, diabetic neuropathy, impacts clinical indicators and patient outcomes. A comprehensive understanding of the complex interplay between diabetic neuropathy, glycemic management, lipid metabolism, and gallbladder function is of the utmost importance.

Objective: The purpose is to use B-mode grey scale ultrasonography to examine the gallbladder's physical properties in people with diabetes and neuropathy.

Methodology: Exams of the gallbladder were compared between a group of 50 people with diabetes and neuropathy and a group of 50 people without diabetes who served as controls. Age, gender, and diabetes duration were used to divide the subjects into subgroups. The diagnosis of neuropathy was established by medical testing. The examination of gallbladder wall thickness, volume, and contractility was undertaken using B-mode grey scale ultrasonography by a consultant radiologist. In order to distinguish between those with diabetic neuropathy and a control group, the data was analyzed using SPSS-28 software to look for significant differences in gallbladder physics parameters.

Results: there were statistically significant differences in fasting blood glucose, HbA1C, lipid profiles, and gallbladder features between the two groups. Low-density lipoprotein (LDL) and very low-density lipoprotein (VLDL) cholesterol levels were found to be significantly higher in those with neuropathy compared to those in the control group. Nevertheless, it was shown that individuals with neuropathy had reduced levels of high-density lipoprotein cholesterol (HDL). The research investigation also identified notable variations in gallbladder parameters among diabetic individuals with neuropathy, indicating potential modifications in gallbladder dynamics or motility. No significant length and wall thickness changes were observed, suggesting these characteristics may remain constant independent of meal intake.

Conclusion: In conclusion, this research underscores the significant influence of diabetic neuropathy on glycemic management, lipid metabolism, and gallbladder function. The identified changes need thorough surveillance and individualised therapeutic approaches to reduce the cardiovascular and gallbladder risks linked to them.

Keywords: Diabetic Neuropathy, Gallbladder, diabetes mellitus (DM), Ejection Fraction

Resumen

Antecedentes: El síntoma prevalente de la diabetes, la neuropatía diabética, impacta los indicadores clínicos y los resultados de los pacientes. Es de suma importancia una comprensión integral de la compleja interacción entre la neuropatía diabética, el control de la glucemia, el metabolismo de los lípidos y la función de la vesícula biliar.

Objetivo: El propósito es utilizar la ecografía en escala de grises en modo B para examinar las propiedades físicas de la vesícula biliar en personas con diabetes y neuropatía.

Metodología: Se compararon los exámenes de la vesícula biliar entre un grupo de 50 personas con diabetes y neuropatía y un grupo de 50 personas sin diabetes que sirvieron como controles. Se utilizaron la edad, el sexo y la duración de la diabetes para dividir a los sujetos en subgrupos. El diagnóstico de neuropatía se estableció mediante pruebas médicas. Un radiólogo consultor realizó el examen del espesor, el volumen y la contractilidad de la pared de la vesícula biliar mediante ecografía en escala de grises en modo B. Para distinguir entre aquellos con neuropatía diabética y un grupo de control, los datos se analizaron utilizando el software SPSS-28 para buscar diferencias significativas en los parámetros físicos de la vesícula biliar.

Resultados: hubo diferencias estadísticamente significativas en la glucemia en ayunas, HbA1C, perfiles lipídicos y características de la vesícula biliar entre los dos grupos. Se encontró que los niveles de colesterol de lipoproteínas de baja densidad (LDL) y de muy baja densidad (VLDL) eran significativamente más altos en aquellos con neuropatía en comparación con los del grupo de control. Sin embargo, se demostró que las personas con neuropatía tenían niveles reducidos de colesterol unido a lipoproteínas de alta densidad (HDL). La investigación también identificó variaciones notables en los parámetros de la vesícula biliar entre personas diabéticas con neuropatía, lo que indica posibles modificaciones en la dinámica o la motilidad de la vesícula biliar. No se observaron cambios significativos en la longitud y el grosor de la pared, lo que sugiere que estas características pueden permanecer constantes independientemente de la ingesta de comida.

Conclusión: En conclusión, esta investigación subraya la influencia significativa de la neuropatía diabética en el manejo de la glucemia, el metabolismo de los lípidos y la función de la vesícula biliar. Los cambios identificados necesitan una vigilancia exhaustiva y enfoques terapéuticos individualizados para reducir los riesgos cardiovasculares y de vesícula biliar relacionados con ellos.

Palabras clave: Neuropatía Diabética, Vesícula Biliar, diabetes mellitus (DM), Fracción de Eyección

Introduction

Diabetes Mellitus (DM) is a chronic metabolic illness that affects several organ systems, and its related consequences often result in substantial morbidity and death. Neuropathy, a common and significant consequence of diabetes mellitus (DM), may present in several manifestations, such as peripheral, autonomic, and focal neuropathies[1-3]. Diabetic autonomic neuropathy has the potential to impact the gastrointestinal system, resulting in impairments in the motility and contractility of the gallbladder. The presence of gallbladder dysfunction in individuals with diabetes is linked to a heightened susceptibility to developing cholelithiasis, cholecystitis, and other biliary problems. Consequently, it is essential to promptly diagnose and treat in such cases[4,5].

B-mode grey scale ultrasonography has become an essential technique for evaluating the anatomical and functional aspects of the gallbladder. It offers insight into gallbladder wall thickness, size, shape, and contractility. This particular imaging modality provides a non-invasive, easily accessible, and cost-effective method for assessing gallbladder parameters, hence assisting in the timely identification and treatment of gallbladder illnesses[6,7].

Despite the evident correlation between diabetes, neuropathy, and gallbladder dysfunction, there exists a dearth of comprehensive research that thoroughly investigates the precise modifications in gallbladder physical characteristics among diabetic individuals with neuropathy. Comprehending these alterations is of utmost importance, as it can facilitate the early detection of individuals at risk, enabling the implementation of preventative measures and prompt therapies[8-11].

The aim of this study is to fill the current knowledge gap by undertaking a thorough assessment of gallbladder physics parameters in diabetic patients with neuropathy by the use of B-mode grey scale ultrasonography.

Methodology

In this study, 50 people with diabetes and neuropathy had their gallbladder health evaluated utilizing a cross-sectional design using a stratified random sample technique. The results were compared to those of a control group of 50 healthy individuals chosen from patients at Al-Mustansiriyah University's national diabetes clinic. Individuals will be categorized into several groups throughout the stratification process based on their age, gender, and diabetes duration. Participants will be selected at random within each stratum. A thorough medical evaluation was performed on all of the participants, including a review of their medical records and a physical examination. This examination is used to confirm the presence of neuropathy. and rule out any other potential causes of gallbladder malfunction. Then, the gallbladder's wall thickness, volume, and contractility were evaluated using B-mode grey scale ultrasonography by a consultant radiologist. Examination of gallbladder ejection fraction, which is measured both before and after a high-fat meal, is used to evaluate gallbladder contractility.

Type 2 diabetics were included if their fasting plasma glucose was more than 7.0mmol/L (126mg/dL) or their postprandial glucose was greater than 11.1mmol/L (200mg/dL), and they were between the ages of 18 and 70 years. For the control group, healthy individuals were selected who were not diabetic and matched with the experimental group in terms of age and sex. The fasting plasma glucose concentration values of these individuals were less than 7.0 mmol/L or 126 mg/dL, similar to those of the volunteers in the experimental group.

The study protocol underwent a thorough evaluation process and received approval from the physiology and medical physics department at the College of Medicine, Baghdad University, Baghdad, Iraq. All volunteers provided informed consent, indicating their complete understanding.

The acquired data undergo statistical analysis using SPSS-28 to discern any noteworthy disparities in gallbladder physics parameters across diabetic individuals with neuropathy and control subjects[12].

Results

The demographic results of this study are shown in Table 1. The analysis shows that there was no significant difference in age group between the control and diabetic patients with neuropathy. Females are more prevalent significantly than males. A higher body mass index (BMI) was significantly observed in diabetic patients with neuropathy.

Table 1: The demographic characteristics of control subjects and diabetic patients with neuropathy.

Characteristics		Control	Diabetic with Neuropathy	*p*-value
Age (Years)	Mean ± SD	59.38 ± 13.01	59.92 ± 8.35	0.0589
	Range	35 - 87	48 -78	
Gender	Male: No (%)	21 (42%)	15 (30%)	0.005*
	Female: No (%)	29 (58%)	35 (70%)	
BMI (Kg/m²)	Mean ± SD	31.92 ± 10.69	32.83 ± 13.47	0.04804*
	Range	22.83 - 84.7	19.33 - 46.81	

*Significant difference at*p*–value ≤0.05.

HbA1C and fasting blood glucose (FBG) (mg/dl) were compared between control and diabetic patients with neuropathy. The levels of these two indicators were significantly greater in patients with diabetes and neuropathy compared to those in the control group, as shown in Table 2. Specifically, there were substantial changes in HbA1C levels (mg/dl) and FBG (mg/dl) between the two study groups, showing the considerable influence of neuropathy on diabetic patients' glycemic control. These findings highlight the possible diabetes management consequences of diabetic neuropathy and underline the significance of monitoring these biomarkers in individuals with neuropathic complications.

Table 2: The HBA1c and fasting blood glucose for the control group and diabetic patients with neuropathy

Markers	Control	Diabetic with Neuropathy	p-value
HbA1C	6.73 ± 1.46	8.37±2.36	0.004*
FBG (mg/dl)	100.34 ± 3.10	189.22 ± 7.98	<0.001*

* Significant difference atp–value ≤0.05.

The lipid profile of the control group and diabetic patients with neuropathy was analysed, and the findings are provided in Table 3. Compared to the control group, diabetic patients with neuropathy had greater levels of Triglyceride (mg/dl), low-density lipoprotein cholesterol (LDL) and very low-density lipoprotein cholesterol (VLDL). In contrast to the control group, high-density lipoprotein cholesterol (HDL) was lower in diabetes patients with neuropathy. Only LDL was significantly different between the two groups.

These results suggest diabetic individuals with neuropathy may have lipid profiles with raised Triglyceride, LDL and VLDL levels and decreased HDL values. The importance of the variation in Triglyceride, LDL highlights the possible influence of diabetic neuropathy on lipid metabolism. These findings emphasise the necessity of cholesterol treatment and monitoring in persons with diabetes and neuropathy to decrease the cardiovascular risks associated with dyslipidemia.

Table 3: lipid profile for control and diabetic patients with neuropathy.

Tests	Control	Diabetic with Neuropathy	p-value
Triglyceride (mg/dl)	124.38 ± 6.49	139.38 ± 6.27	0.682
LDL (mg/dl)	106.50 ± 5.63	120.14 ± 3.20	<0.001*
HDL (mg/dl)	43.90 ± 1.54	38.47 ± 1.48	0.544
VLDL (mg/dl)	28.38 ± 1.62	29.36 ± 1.34	0.181

* Significant difference atp–value ≤0.05.

The comparison of pre- and post-meal gallbladder parameter measurements between a control subject and diabetic patients with neuropathy was given in Table 4. Several measures, including Anteroposterior AP diameter in both pre-and post-prandial stages, transverse diameter in pre- and post-prandial states (cm), gallbladder volume in the pre-prandial state (cm^3), and gallbladder ejection fraction (%), were considerably significant in diabetic individuals with neuropathy. The length (cm), the wall thickness in both the pre-and post-prandial phases (cm), and gallbladder volume in the post-prandial state did not change significantly (cm^3).

These results suggest that the gallbladder parameters of diabetic patients with neuropathy exhibit distinct patterns in response to meal consumption, particularly in Anteroposterior AP and transverse diameters and gallbladder volume, possibly indicating altered gallbladder dynamics or motility in this subgroup. However, no significant changes in length and wall thickness were observed, suggesting that these characteristics may stay essentially constant independent of meal intake in both healthy participants and diabetic patients without neuropathy. The fundamental processes leading to these disparities and their therapeutic consequences in diabetes individuals with neuropathy need more exploration.

Table 4. The Gallbladder Parameters for control subjects and diabetic patients with neuropathy pre and post-prandial.

Tests	Control	Diabetic with Neuropathy	*p*-value
AP Diameter Pre-Prandial (cm)	4.77 ± 1.08	2.98 ± 0.07	0.002*
AP diameter Post prandial (cm)	2.16 ± 0.17	1.65 ± 0.05	0.003*
Length Pre-Prandial (cm)	7.37 ± 0.17	6.83 ± 0.08	< 0.001*
Length Post Prandial (cm)	5.18 ± 0.17	5.49 ± 1.06	0.455
Transverse diameter Pre-Prandial (cm)	3.14 ± 0.13	2.87 ± 0.06	0.013*
Transverse diameter Post Prandial (cm)	2.46 ± 0.23	1.55 ± 0.03	<0.001*
Wall Thickness Pre-Prandial (cm)	2.44 ± 0.068	2.72 ± 0.47	0.174
Wall Thickness Post Prandial (cm)	2.82 ± 0.072	3.54 ± 0.06	0.480
Gallbladder Volume Pre-Prandial (cm^3)	40.76 ± 3.45	27.93 ± 0.88	< 0.001*
Gallbladder Volume Post Prandial (cm^3)	22.95 ± 1.90	14.62 ± 0.25	< 0.001*
Gallbladder Ejection Fraction %	40.41±3.45	27.76 ± 0.88	< 0.001*

* Significant difference at p–value ≤0.05.

Discussion

In recent years, the complicated interaction between diabetes, its related complications, and the ensuing modifications in several metabolic markers has been a focus area of study. This paper delves into the significant changes observed in glycemic control, lipid profiles, and gallbladder parameters between control subjects and diabetic patients with neuropathy, offering a comprehensive analysis of the underlying implications and future directions in diabetes management and research[13,14].

The higher values of HbA1C in diabetic patients with neuropathy as compared to the control group underline the severe effect of neuropathy on glycemic management. HbA1C, a trustworthy index of long-term glucose management, represents the episodic swings in blood glucose levels and the accumulated glycemic history over many months. The considerable spike in HbA1C levels in the neuropathic subgroup implies a disturbed metabolic state, needing careful monitoring and management to decrease the risk of long-term

diabetes consequences. The study agreed with Nozawa et al. 2022[15] and Lai et al., 2019[16] when their research underscores the crucial necessity for customised care methods in diabetic patients with neuropathy, aiming for tight glucose control to avoid or halt the advancement of neuropathic alterations.

The lipid profile disparities between the control group and diabetic individuals with neuropathy indicate a pattern associated with elevated cardiovascular risk. Elevated levels of LDL and VLDL, along with lower HDL levels, portray a picture of dyslipidemia, a well-established risk factor for cardiovascular illnesses. The importance of the variance in LDL levels further underlines the possible effect of diabetic neuropathy on lipid metabolism, adding a layer of complication to the treatment of dyslipidemia in this subgroup. This needs a proactive strategy in cholesterol medication and frequent monitoring to recalibrate the lipid profile towards a more favourable cardiovascular risk profile. The results of this study agreed with Song et al, 2016[17], Al Quran et al, 2022[18], and Lokopo et al, 2022[19].

The different patterns identified in gallbladder parameters between diabetic patients with neuropathy and control participants are suggestive of altered gallbladder dynamics or motility. The considerable variations in Anteroposterior AP and transverse diameters and gallbladder volume in response to meal ingestion show a probable impairment in gallbladder function. However, the consistency in gallbladder length and wall thickness independent of meal consumption indicates that these measures may be untouched by the neuropathic process. This dichotomy raises fascinating issues concerning the specific sensitivity of some gallbladder parameters to diabetic neuropathy, prompting more exploration to untangle the underlying processes and their therapeutic implications. Ikhuoriah et al. 2022[20] study comparing the gallbladder (GB) in adults with type 2 diabetes and a non-diabetic control group found that people with diabetes had higher FGBV, GB wall thickness, and gallstone presence compared to non-diabetic controls. The study found that B-mode ultrasound is a crucial non-invasive tool for detecting these changes early, as it can help prevent and treat gallstones and cholecystitis. The findings suggest that early detection of gallbladder changes can help prevent and treat diabetes.

Conclusions

Findings given in this research underline the severe influence of diabetic neuropathy on different metabolic and gallbladder markers, providing a picture of a damaged physiological condition. The changes above in glycemic control, lipid profiles, and gallbladder dynamics underscore the need for a comprehensive and individualised strategy in the treatment of diabetic individuals with neuropathy. Future research endeavours should focus on elucidating the fundamental processes that drive these changes, intending to discover innovative treatment approaches to minimise the hazards associated with these modifications.

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