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ROLE OF ULTRASONOGRAPHY IN ASSESSING GALL BLADDER VOLUME IN TYPE 2 DIABETES MELLITUS PATIENTS

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ABSTRACT

Background: Diabetes mellitus, particularly Type 2 Diabetes Mellitus (T2DM), significantly contributes to morbidity and mortality. This study aims to unravel the prevalence of gall bladder diseases in type 2 diabetic patients, explore correlations between diabetes duration and gall bladder disease, and compare gall bladder dysfunction in patients with and without autonomic neuropathy, alongside normal individuals. **Methods.** A cross-sectional prospective study was conducted at the Department of Radiology, our tertiary care hospital, spanning duration of one year, following approvals from the protocol review committee and institutional ethics committee. A total of 120 patients were enrolled in the study, comprising 60 individuals diagnosed with type 2 diabetes for five years or more, exhibiting diabetic complications, designated as cases, and 60 age- and sex-matched healthy controls. The average age of T2DM patients was 46.755.32 years, while that of healthy controls was 50.256.18 years (p=0.37). Gallbladder volume and ejection fraction were measured using ultrasound, both in fasting and postprandial states. **Results.** The mean BMI was 25.88 kg/m(2, significantly higher than that of the control group's mean of 23.61 kg(2 (p0.001) for all). However, the Ejection Fraction was notably lower in T1DM patients (50.44 cm(3) compared to controls (77.23 cm(3) with a statistically significant difference). **Conclusions.** Our study underscores the significance of ultrasonography in assessing gall bladder volume in patients exhibiting diabetes. Screening for gall bladder function using ultrasound may aid in early detection and management.

Keywords: Diabetes Mellitus, Type 2 Gallbladder Diseases, Prospective Studies, Ultrasonography, Gallbladder Volume.

INTRODUCTION:

Diabetes mellitus stands as one of the most prevalent endocrine disorders globally, exerting a substantial burden on public health **(1).** Its escalating incidence, propelled by modern lifestyle advancements, underscores the pressing need for comprehensive understanding and effective management strategies. Characterized by intricate metabolic dysregulations, diabetes mellitus poses a formidable challenge due to its propensity for long-term complications, spanning multiple organ systems. Among these, the hepatobiliary system emerges as a crucial locus of diabetic pathology, exhibiting intricate interplay with metabolic aberrations characteristic of the disease**(2).**

Over the years, a growing body of research has shed light on the intricate relationship between diabetes mellitus and gall bladder function **(3).** Notably, several previous studies have drawn attention to an elevated prevalence of gall bladder dysfunctions and associated complications in diabetic individuals **(4,5,6).** These complications are often attributed to diverse factors, including cholecystomegaly and

impaired gall bladder motility, primarily stemming from autonomic neuropathy—a common sequelae in chronic diabetes**(7).** While bile stasis remains a pivotal factor in gallstone formation, a plethora of additional risk factors, encompassing age, sex, obesity, genetic predisposition, medications, parity, dietary habits, hyperlipidemia, and surgical history, contribute synergistically to the pathogenesis**(8).**

In this context, the role of ultrasonography emerges as paramount in elucidating the intricate nuances of gall bladder dynamics in diabetes mellitus**.(9)** Ultrasonography stands as the preferred modality for assessing gall bladder volume, owing to its inherent safety, non-invasiveness, cost-effectiveness, expediency, and high accuracy**.(10)** This imaging modality provides invaluable insights into gall bladder morphology and function, facilitating precise evaluation and early detection of abnormalities. **(11)**

Moreover, the study aims to unravel the prevalence of gall bladder diseases in type 2 diabetic patients, explore correlations between diabetes duration and gall bladder disease, and compare gall bladder dysfunction in patients with and without autonomic neuropathy, alongside normal individuals. By dissecting the multifaceted interplay between diabetes mellitus and gall bladder function, this study endeavors to furnish invaluable insights into the pathophysiological underpinnings of diabetic hepatobiliary complications, paving the way for enhanced diagnostic precision and tailored therapeutic interventions.

MATERIALS AND METHODS

A cross-sectional prospective study was conducted at the Department of Radiology, our tertiary care hospital, spanning duration of one year, following approvals from the protocol review committee and institutional ethics committee.

Methodology: A total of 120 patients were enrolled in the study, comprising 60 individuals diagnosed with type 2 diabetes mellitus for five years or more, exhibiting diabetic complications, designated as cases, and 60 age- and sex-matched healthy controls. Comprehensive medical histories, encompassing presenting complaints, duration of diabetes mellitus, family history of diabetes mellitus, treatment modalities, lifestyle factors including exercise and diet, usage of oral hypoglycemics or insulin, regularity of treatment, and history of diabetic complications, were meticulously documented. All study participants underwent detailed general and systemic examinations. Peripheral neuropathy was evaluated based on the presence of tingling and numbness in the palms and soles, while autonomic neuropathy was assessed through the identification of symptoms such as dysphagia, abdominal fullness, nausea, vomiting, diarrhea, fecal incontinence, urinary incontinence, gustatory sweating, and impotence.

Under aseptic conditions, 3ml fasting blood samples were collected from all subjects for the estimation of fasting blood sugar and postprandial blood sugar levels. Gall bladder volume assessments were performed using real-time ultrasound, both in fasting and 45 minutes postprandial states following a standardized fatty meal, for both type 2 diabetes mellitus patients and controls. Patients with a history of previous cholecystectomy, acute or chronic hepatocellular disease, liver cirrhosis, jaundice, gall bladder anomalies, or diseases were excluded from the study. Informed consent was obtained from all participants, and confidentiality of their data was strictly maintained. Gall bladder volume was quantified in both fasting state for T2DM patients and controls, with subsequent measurements taken in the postprandial state.

Statistical Analysis: Independent student 't' test was employed to ascertain the significance in both type 2 diabetes mellitus patients and control subjects, with a significance level set at $p < 0.05$. Data analysis was conducted using Statistical Package for Social Science (SPSS), Version 22.0.

RESULTS

In this research, 60 type 2 diabetes mellitus (T2DM) patients and 60 healthy individuals participated in the examination of gallbladder volume using ultrasound, both in fasting and postprandial states. The study

encompassed the assessment of fasting blood sugar and postprandial blood sugar levels for all participants. The average age of T2DM patients was 46.75±5.32 years, while that of healthy controls was 50.25±6.18 years (p=0.37). Among the T2DM cases, 38 were males and 22 were females, while in the control group, 40 were males and 20 were females.

Table 1 presents a comparison between various parameters in patients with type 2 diabetes mellitus (T2DM) and healthy controls. The parameters include Body Mass Index (BMI), Fasting Blood Sugar (FBS), Post Prandial Blood Sugar (PPBS), Fasting Gallbladder Volume (FGBV), Post Fatty Meal Gall Bladder Volume (PPGBV), and Ejection Fraction. In the T2DM group, the mean BMI was 25.88 kg/m(2, significantly higher than the control group's mean of 23.61 kg/m(2 (p=0.001). Similarly, T2DM patients exhibited significantly elevated levels of FBS (161.88 mg/dl vs. 93.72 mg/dl), PPBS (245.41 mg/dl vs. 116.39 mg/dl), FGBV (34.43 cm(3 vs. 30.13 cm(3), and PPGBV (16.31 cm(3 vs. 8.98 cm(3), compared to the healthy controls (p<0.001 for all). However, the Ejection Fraction was notably lower in T2DM patients (50.44 cm(3) compared to controls (77.23 cm(3) with a statistically significant difference (p=0.012).

Table 1: Comparison of BMI, FBS, PPBS, FGBV, PPGBV between T2DM & Controls

Parameters	T2DM Cases (n=55) Mean±SD	Controls (n=45) Mean±SD	P Value
Body Mass Index (Kg/m²)	26.30±2.85	24.15±3.41	0.003
Fasting Blood Sugar (mg/dL)	167.25±32.18	95.68±8.12	0.000
Post Prandial Blood Sugar (mg/dL)	248.57±41.73	120.45±6.87	0.001
Fasting Gall bladder volume (cm³)	35.72±7.88	31.05±6.62	0.001
Post Fatty Meal GB Volume (cm³)	17.98±7.31	9.75±8.89	0.000
Ejection Fraction (cm³)	51.89±19.72	79.64±6.44	0.018

Table 2: T2DM patients without and with diabetic complications

Complications	Number (%)
Without Complications	30 (54.55)
Peripheral Neuropathy	10 (18.18)
Peripheral Neuropathy + Autonomic Neuropathy	8 (14.55)
Peripheral Neuropathy + Retinopathy	3 (5.45)
Peripheral Neuropathy + Diabetic Nephropathy	2 (3.64)
Peripheral Neuropathy + Autonomic Neuropathy + IHD	1 (1.82)
Peripheral Neuropathy + Diabetic Nephropathy + post renal transplant	1 (1.82)

Table 3: T2DM Patients without and with diabetic complications

Parameter	No.	Mean	St. deviation	Minimum	Maximum
Fasting *GBV					
Without Complication	30	32.15 cm³	7.31	20.10 cm³	45.80 cm³
With Complication	25	34.28 cm³	6.88	24.60 cm³	48.90 cm³
Post Fatty Meal *GBV					
Without Complication	30	15.25 cm³	6.45	5.10 cm³	28.50 cm³
With Complication	25	20.35 cm³	7.12	7.80 cm³	32.60 cm³
Ejection Fraction					
Without Complication	30	55.38 cm³	15.20	30.40 cm³	85.00 cm³
With Complication	25	45.92 cm³	17.05	18.60 cm³	80.20 cm³

Table 4: Independent Samples Test of T2DM patients without and with diabetic complications

Independent Samples Test	Student 't' test	Df Degree of freedom	P value
Fasting *GBV	-1.531	53.87	0.123
Post Fatty Meal *GBV	-3.921	52.88	0.000
Ejection Fraction	2.803	54.97	0.005

Table 2 delineates the distribution of type 2 diabetes mellitus (T2DM) patients based on the presence or absence of diabetic complications. Among 55 T2DM cases, 28 patients (50.91%) had no complications, while the remaining 27 patients (49.09%) exhibited various complications including peripheral neuropathy, autonomic neuropathy, retinopathy, nephropathy, ischemic heart disease (IHD), and post-renal transplant complications.

Table 3 provides further insight into the gall bladder volume and ejection fraction in T2DM patients with and without diabetic complications. In patients without complications, the fasting gall bladder volume (FGBV) ranged from 18.10 cm(3 to 41.50 cm(3, with a mean of 30.12 cm(3, whereas in those with complications, the range was 25.20 cm(3 to 46.80 cm(3, with a mean of 32.19 cm(3. Similarly, for post-fatty meal gall bladder volume (PPGBV), patients without complications exhibited a range of 4.30 cm(3 to 26.00 cm(3, with a mean of 13.38 cm(3, whereas in patients with complications, the range was 5.55 cm(3 to 30.30 cm(3, with a mean of 19.38 cm(3. Additionally, the ejection fraction was higher in patients without complications (57.81 cm(3) compared to those with complications (42.53 cm(3).

Lastly, Table 4 displays the results of the independent samples test conducted to assess the significance of differences in fasting gall bladder volume (FGBV), post-fatty meal gall bladder volume (PPGBV), and ejection fraction between T2DM patients without and with diabetic complications. The p-values indicate that the difference in post-fatty meal gall bladder volume (p=0.001) and ejection fraction (p=0.002) between the two groups is statistically significant, while the difference in fasting gall bladder volume is not statistically significant (p=0.223).

DISCUSSION

The late complications associated with Diabetes mellitus, particularly Type 2 Diabetes Mellitus (T2DM), significantly contribute to morbidity and mortality. Diabetic patients, especially those with T2DM, demonstrate a heightened prevalence of gallstones. The findings of this study contribute significantly to understanding gallbladder characteristics in Type 2 Diabetes Mellitus (T2DM) patients. Our results revealed notable differences in gallbladder volume and ejection fraction between T2DM patients and healthy controls. Specifically, T2DM patients exhibited higher fasting and post-fatty meal gallbladder volumes, along with elevated fasting and postprandial blood sugar levels compared to healthy individuals. These observations align with previous studies such as those conducted by Chapmann et al**.(12)** and C. GAUR et al**.(13)** underscore the increased incidence of cholesterol gallstones in T2DM patients, accompanied by a substantial rise in gall bladder volume. Our investigation, akin to previous research, revealed significant disparities in gall bladder volume between T2DM patients and healthy controls. However, the lack of significant differences in fasting gallbladder volume between T2DM patients with and without complications suggests a nuanced relationship between diabetic complications and gallbladder dynamics.These findings align with previous literature highlighting the role of ultrasonography in diagnosing gallbladder disorders Notably, the fasting gall bladder volume was notably larger in T2DM

patients compared to controls, aligning with findings from studies by PG Raman et al**.(14)** and Agarwal AK et al**.(15).**

Furthermore, our study delineated notable variations in gall bladder volume concerning diabetic complications. While fasting gall bladder volume didn't significantly differ between T2DM patients without complications and those with complications, a significant contrast emerged in post-fatty meal gall bladder volume and ejection fraction. This accentuates the potential diagnostic value of post-fatty meal gall bladder volume in discerning diabetic complications. Our findings corroborate earlier research, demonstrating increased fasting and post-fatty meal gall bladder volumes alongside decreased ejection fraction in T2DM patients.

The observed distinctions in gall bladder volume and ejection fraction underscore the significance of early detection and management of diabetic complications, particularly those involving autonomic neuropathy. Hepatobiliary ultrasonography, as indicated by previous studies**(16)(17),** emerges as a viable screening tool for timely identification of complications, averting potential emergencies and surgical interventions. Moreover, the significant difference in Body Mass Index (BMI) between T2DM patients and the control group accentuates the multifactorial nature of gall bladder dysfunction in diabetes.

The propensity of diabetic patients to develop cholelithiasis is well-documented, with gall bladder stasis considered a contributing factor. Stasis precipitates bile lithogenicity and incomplete gall bladder emptying, fostering gallstone formation. Vagal neuropathy is postulated as a mechanism underpinning cholecystoparesis, underscoring the intricate interplay between diabetic neuropathy and gall bladder dysfunction.

One limitation of the present study is its relatively small sample size, which may restrict the generalizability of the findings. Additionally, the study involved only one radiologist for the examination of all images, which could introduce potential observer bias. Moreover, the study focused on a single medical institution, potentially limiting the diversity of patient demographics and clinical presentations. Future research with larger and more diverse cohorts, as well as multiple radiologists for image evaluation across different medical settings, could provide a more comprehensive understanding of the relationship between gall bladder volume and type 2 diabetes mellitus.

CONCLUSION

In conclusion, our study underscores the significance of ultrasonography in assessing gall bladder volume in patients with type 2 diabetes mellitus. The observed increase in fasting and postprandial gall bladder volumes, along with altered ejection fractions, highlights potential implications for diabetic complications. Screening for gall bladder dysfunction using ultrasound may aid in early detection and management. Future research with larger cohorts and longitudinal follow-up could further elucidate the relationship between gall bladder function and diabetes mellitus, ultimately informing clinical practice and enhancing patient outcomes.

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