

Ultrasonographic evaluation of gallbladder in adult diabetic patients in BMCH, Barpeta, Assam

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Abstract

Background: Diabetes mellitus is associated with various hepatobiliary abnormalities, including gallstone disease and other gallbladder lesions. Ultrasonography provides a non-invasive method for evaluating gallbladder morphology and pathology.

Objective: To evaluate the ultrasonographic findings of the gallbladder in adult patients with type II diabetes mellitus at Barpeta Medical College and Hospital, Barpeta, Assam.

Materials and Methods: A hospital-based cross-sectional study was conducted among 100 adult patients with type II diabetes mellitus referred for abdominal ultrasonography. Gallbladder examination was performed after 12 hours of fasting using an ALPINION XCUBE 90 ultrasound system with a 2–5 MHz curved-array transducer. Gallbladder dimensions were measured and volume was calculated using the ellipsoid formula ($\pi/6 \times L \times W \times H$). Demographic characteristics,

symptoms, morphological variations and pathological findings were recorded and analyzed statistically.

Results: Of the 100 participants, 54 (54.0%) were females and 46 (46.0%) were males. The mean age was 60.20 ± 8.67 years. The mean gallbladder volume was 31.36 ± 7.03 cc. Cholelithiasis was the most common pathological finding, detected in 20.0% of participants, followed by sludge (11.0%), polyps (6.0%), calculus cholecystitis (4.0%), adenomyomatosis (4.0%) and acalculous cholecystitis (1.0%). A Phrygian cap was observed in 3.0% of participants, while no ectopic gallbladder or gallbladder carcinoma was detected. No statistically significant association was observed between gender and age-group distribution or gallbladder volume categories. Similarly, no significant gender association was observed with clinical symptoms or individual pathological findings.

Conclusion: Gallbladder abnormalities were frequently detected on ultrasonography among adult patients with

type II diabetes mellitus, with cholelithiasis being the most common finding. Ultrasonography is a useful non-invasive modality for comprehensive evaluation of gallbladder morphology and pathology in diabetic patients.

Keywords: Type II Diabetes Mellitus, Gallbladder; Ultrasonography, Cholelithiasis, Biliary Sludge, Gallbladder Volume.

Introduction

The gallbladder is an important component of the biliary system that stores and concentrates bile and releases it into the duodenum during digestion. Gallbladder disorders include cholelithiasis, cholecystitis, biliary sludge, polyps, adenomyomatosis and malignant lesions. Gallstone disease is influenced by several factors, including increasing age, female sex, ethnicity, family history, obesity and metabolic abnormalities^{1,2}.

Type II diabetes mellitus (T2DM) is a common metabolic disorder that may be associated with hepatobiliary abnormalities. Several studies have reported an increased risk of gallbladder disease among individuals with diabetes mellitus³. A systematic review and meta-analysis of prospective studies found that diabetes was associated with an increased risk of gallbladder disease, supporting an epidemiological relationship between the two conditions⁴.

The association between diabetes and gallstone formation is considered multifactorial. Insulin resistance and altered lipid metabolism may increase hepatic cholesterol secretion into bile, resulting in cholesterol supersaturation. In addition, diabetes-related autonomic dysfunction and impaired gallbladder motility may promote bile stasis and contribute to gallstone formation⁵.

Gallstone disease is one of the most common disorders of the gallbladder. Although many gallstones remain asymptomatic, they may cause biliary colic, cholecystitis, obstruction and other complications. The prevalence of gallstone disease varies according to geographical region, age and sex. Indian population-based studies have demonstrated substantial geographical variation in gallbladder disease and have identified diabetes and other demographic factors among associated risk factors⁶. Similarly, an Indian hospital-based study reported gallstones in 16% of patients with type II diabetes mellitus compared with 5% of controls, further supporting the relevance of gallbladder evaluation in diabetic patients⁷.

Ultrasonography is an important imaging modality for evaluation of the gallbladder because it is non-invasive, readily available, relatively inexpensive and does not involve ionizing radiation. It can demonstrate gallstones, biliary sludge, gallbladder wall abnormalities and other structural lesions. Ultrasonography is also considered an appropriate imaging technique for assessment of gallstone disease and gallbladder morphology⁸.

Adequate fasting is important before gallbladder ultrasonography because food intake causes gallbladder contraction and may reduce the visualized lumen. Gallbladder dimensions can be measured sonographically, and its volume can be estimated using the ellipsoid method based on the maximum longitudinal, transverse and anteroposterior dimensions. The validity of the sonographic ellipsoid method for estimating gallbladder volume was demonstrated by Dodds et al.⁹.

Ultrasonography can also identify anatomical variants and benign gallbladder abnormalities. A Phrygian cap is a benign morphological variant produced by folding of

the gallbladder fundus and should be recognized to avoid misinterpretation as a pathological lesion. Gallbladder polyps are another important sonographic finding. Although many are benign, appropriate assessment is important because selected lesions may have malignant potential¹⁰.

Gallbladder polyps are commonly detected incidentally during transabdominal ultrasonography. Current recommendations emphasize appropriate assessment and follow-up according to polyp characteristics and risk factors¹¹. Biliary sludge is another sonographic abnormality that may occur because of bile stasis and may sometimes precede gallstone formation⁸.

The epidemiology of gallstone disease demonstrates important differences between populations. Age, sex and metabolic factors contribute to variation in disease occurrence, and Indian studies have reported considerable regional variation in gallbladder disease^{6,12}. These differences highlight the importance of generating local data from specific populations and healthcare settings.

Although gallbladder abnormalities have been studied among diabetic populations, limited information is available regarding the complete spectrum of sonographic gallbladder findings among adult diabetic patients in Assam. The present study was therefore undertaken to evaluate the gallbladder ultrasonographically in adult patients with type II diabetes mellitus attending Fakhruddin Ali Ahmed Medical College and Hospital (FAAMCH), Barpeta, Assam. The study evaluated demographic characteristics, presenting symptoms, gallbladder volume, morphological variations and pathological findings and assessed their association with gender.

Materials and Methods

Study Design and Setting

A hospital-based cross-sectional study was conducted among patients with clinically diagnosed type II diabetes mellitus who were referred for ultrasonography of the abdomen to the Department of Radiodiagnosis, Barpeta Medical College and Hospital, Barpeta, Assam. The study was conducted over a period of one year.

Study Population

The study included adult male and female patients with clinically diagnosed type II diabetes mellitus who fulfilled the predefined eligibility criteria and were referred for abdominal ultrasonography during the study period.

Inclusion Criteria

- Male and female patients with a clinical diagnosis of type II diabetes mellitus.
- Patients willing to participate in the study and providing written informed consent.

Exclusion Criteria

Patients were excluded if they:

- Did not provide informed consent.
- Were pregnant.
- Had undergone previous cholecystectomy.
- Had a history of alcoholism.
- Were obese.

Sample Size

The sample size was calculated considering a prevalence (p) of 50%, which was chosen to obtain the maximum sample size in the absence of a reliable estimate of prevalence. The following formula was used:

$$n = 4pq/d^2$$

Where:

n = required sample size

p = anticipated prevalence = 50%

$$q = 100 - p = 50\%$$

d = allowable error = 10%

Thus:

$$n = 4 \times 50 \times 50 / 10^2 = 100$$

Therefore, a total of 100 patients were included in the study.

Ethical Considerations

Prior to commencement of the study, ethical approval was obtained from the Institutional Ethics Committee of Barpeta Medical College and Hospital, Barpeta, Assam. All participants were informed about the objectives and procedures of the study, and written informed consent was obtained before enrolment.

Data Collection

Patients fulfilling the eligibility criteria were enrolled after obtaining written informed consent. Each participant was interviewed, and demographic characteristics, including age and sex, were recorded using a predesigned case proforma. Relevant clinical history, physical examination findings, and available laboratory investigation results were also documented. All collected information was entered systematically into the study proforma for subsequent analysis.

Ultrasonographic Examination

Ultrasonographic examination of the gallbladder was performed using an ALPINION XCUBE 90 ultrasound scanner equipped with a low-frequency curved-array transducer of 2–5 MHz.

Gallbladder evaluation was performed using routine sagittal and transverse sonographic planes. When the gallbladder was not adequately visualized, additional subcostal oblique views were obtained to evaluate the gallbladder fossa and avoid missing gallbladder abnormalities. The transducer was positioned with the left edge more cephalad than the right edge and directed

towards the right shoulder to adequately visualize the gallbladder fossa.

Since ingestion of food, particularly fatty food, causes gallbladder contraction and may result in apparent wall thickening or obscure luminal and mural abnormalities, all participants underwent gallbladder examination after adequate fasting. In the present study, gallbladder volume was measured following 12 hours of overnight fasting.

Measurement of Gallbladder Volume

The maximum longitudinal length (L), maximum transverse width (W), and maximum anteroposterior height (H) of the gallbladder were measured on ultrasonography. Gallbladder volume was calculated using the ellipsoid method:

$$\text{Gallbladder volume} = \pi/6 \times L \times W \times H$$

where L, W, and H represent the maximum longitudinal, transverse, and anteroposterior dimensions, respectively. The measurements and sonographic findings were recorded for each participant in the study proforma.

Statistical Analysis

The collected data were coded and entered into a Microsoft Excel worksheet and subsequently analyzed statistically. Categorical variables were expressed as frequencies, proportions, ratios, and percentages. Continuous variables were expressed as mean $\pm$ standard deviation (SD). The Chi-square (χ^2) test was used to assess associations between categorical variables. A suitable level of statistical significance was considered for interpretation of the results.

Results and Observations

A total of 100 patients with type II diabetes mellitus were included in the present cross-sectional study. The demographic characteristics, clinical symptoms, gallbladder volume, morphological variations,

pathological findings, and their associations with gender were evaluated.

Table 1: Gender-wise distribution of study participants

Gender	No. of patients	Percentage (%)
Male	46	46.00
Female	54	54.00
Total	100	100.00

Observation: Females constituted the majority of the study population (54.0%), while males accounted for 46.0%. The female-to-male ratio was approximately 1.17:1.

Table 2: Age-wise distribution of study participants

Age group (years)	No. of patients	Percentage (%)
41–45	6	6.00
46–50	10	10.00
51–55	15	15.00
56–60	20	20.00
61–65	21	21.00
66–70	11	11.00
71–75	17	17.00
Total	100	100.00
Mean $\pm$ SD	60.20 $\pm$ 8.67	—

Observation: The largest proportion of participants belonged to the 61–65-year age group (21.0%), followed by the 56–60-year group (20.0%). The lowest proportion was observed in the 41–45-year group (6.0%). The mean age of the study participants was 60.20 $\pm$ 8.67 years.

Table 3: Distribution of patients according to presenting symptoms

Symptom	Present, n (%)	Absent, n (%)
Pain	17 (17.0)	83 (83.0)
Fever	25 (25.0)	75 (75.0)
Vomiting	35 (35.0)	65 (65.0)

Tenderness	6 (6.0)	94 (94.0)
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Observation: Vomiting was the most frequently reported symptom, present in 35.0% of patients, followed by fever (25.0%), pain (17.0%), and tenderness (6.0%).

Table 4: Distribution of patients according to gallbladder volume

Gallbladder volume (cc)	No. of patients	Percentage (%)
15.0–20.0	18	18.00
20.1–25.0	7	7.00
25.1–30.0	9	9.00
30.1–35.0	34	34.00
35.1–40.0	20	20.00
40.1–45.0	9	9.00
45.1–50.0	3	3.00
Total	100	100.00
Mean $\pm$ SD	31.36 $\pm$ 7.03	—

Observation: The most common gallbladder volume category was 30.1–35.0 cc (34.0%), followed by 35.1–40.0 cc (20.0%). The recorded gallbladder volume ranged from 15.70 to 49.30 cc, with a mean volume of 31.36 $\pm$ 7.03 cc.

Table 5: Summary statistics of age and gallbladder volume

Parameter	Age (years)	Gallbladder volume (cc)
Minimum	42.00	15.70
Maximum	75.00	49.30
Range	33.00	33.60
Mean	60.20	31.36
Standard deviation	8.77	7.03
Standard error	0.88	0.70

Observation: The age of the participants ranged from 42 to 75 years, with a mean of approximately 60.20 years.

Gallbladder volume ranged from 15.70 to 49.30 cc, with a mean volume of 31.36 ± 7.03 cc.

Note: Your original Table 5 states the age range as 37.00, but based on the reported minimum (42) and maximum (75), the calculated range is 33.00 years. I have corrected this arithmetically while retaining the reported minimum, maximum, mean, and SD.

Table 6: Distribution according to gallbladder morphology

Morphological finding	Present, n (%)	Absent, n (%)
Gallbladder in normal fossa	100 (100.0)	0 (0.0)
Ectopic gallbladder	0 (0.0)	100 (100.0)
Phrygian cap	3 (3.0)	97 (97.0)

Observation: All 100 participants (100.0%) had the gallbladder located in the normal gallbladder fossa. No ectopic gallbladder was identified. A Phrygian cap, an anatomical morphological variant, was observed in 3.0% of participants.

Table 8: Association of gender with age groups and gallbladder volume

Variable	Category	Male, n (%)	Female, n (%)	Total
Age group	41–45 years	2 (33.33)	4 (66.67)	6
	46–50 years	4 (40.00)	6 (60.00)	10
	51–55 years	7 (46.67)	8 (53.33)	15
	56–60 years	11 (55.00)	9 (45.00)	20
	61–65 years	9 (42.86)	12 (57.14)	21
	66–70 years	4 (36.36)	7 (63.64)	11
	71–75 years	9 (52.94)	8 (47.06)	17
Chi-square		2.0122		
p-value		0.9191		
Gallbladder volume	15.0–20.0 cc	9 (50.00)	9 (50.00)	18
	20.1–25.0 cc	3 (42.85)	4 (57.14)	7
	25.1–30.0 cc	4 (44.44)	5 (55.55)	9

Table 7: Distribution according to gallbladder pathological findings

Pathological finding	Present, n (%)	Absent, n (%)
Cholelithiasis	20 (20.0)	80 (80.0)
Calculus cholecystitis	4 (4.0)	96 (96.0)
Acalculous cholecystitis	1 (1.0)	99 (99.0)
Sludge	11 (11.0)	89 (89.0)
Polyp	6 (6.0)	94 (94.0)
Adenomyomatosis	4 (4.0)	96 (96.0)
Gallbladder carcinoma	0 (0.0)	100 (100.0)

Observation: Cholelithiasis was the most frequent pathological finding (20.0%), followed by gallbladder sludge (11.0%) and polyps (6.0%). Calculus cholecystitis and adenomyomatosis were each observed in 4.0% of participants, while acalculous cholecystitis was observed in 1.0%. No case of gallbladder carcinoma was detected.

	30.1–35.0 cc	15 (44.11)	19 (55.88)	34
	35.1–40.0 cc	9 (45.00)	11 (55.00)	20
	40.1–45.0 cc	5 (55.55)	4 (44.44)	9
	45.1–50.0 cc	1 (33.33)	2 (66.66)	3
Chi-square		2.9872		
p-value		0.3941		
Total		46 (46.0)	54 (54.0)	100

Observation: There was no statistically significant association between gender and age-group distribution ($\chi^2 = 2.0122$, $p = 0.9191$). Similarly, the distribution of gallbladder volume categories did not differ significantly between males and females ($\chi^2 = 2.9872$, $p = 0.3941$).

Table 9: Association of gender with clinical symptoms, morphological findings and pathological findings

Parameter	Finding	Male Present	Male Absent	Female Present	Female Absent	χ^2	p-value
Symptoms	Pain	9	37	8	46	0.397	0.529
	Fever	13	33	12	42	0.483	0.487
	Vomiting	18	28	17	37	0.639	0.424
	Tenderness	2	44	4	50	0.048	0.826
Morphology	Normal GB fossa	46	0	54	0	—	—
	Ectopic	0	46	0	54	—	—
	Phrygian cap	2	44	1	53	0.020	0.888
Pathological findings	Cholelithiasis	8	38	12	42	0.362	0.547
	Calculus cholecystitis	1	45	3	51	0.121	0.728
	Acalculous cholecystitis	1	45	0	54	0.007	0.936
	Sludge	3	43	8	46	1.745	0.187
	Polyp	4	42	2	52	0.391	0.532
	Adenomyomatosis	2	44	2	52	0.000	1.000
	Gallbladder Carcinoma	0	46	0	54	—	—

Discussion

The present hospital-based cross-sectional study evaluated ultrasonographic gallbladder findings among 100 adult patients with type II diabetes mellitus. Females constituted 54.0% of the study population, while males constituted 46.0%, giving a female-to-male ratio of

approximately 1.17:1. The mean age of the participants was 60.20 ± 8.67 years. The largest proportion belonged to the 61–65-year age group (21.0%), followed by the 56–60-year group (20.0%). Increasing age and female sex are recognized epidemiological factors associated with gallstone disease^{1,12}.

The slight female predominance observed in the present study is consistent with the established epidemiological pattern of gallstone disease. However, the present study was specifically conducted among diabetic patients and was not designed to determine the independent effect of sex on gallbladder disease.

The predominance of older participants may partly reflect the age distribution of individuals with established type II diabetes mellitus. Increasing age is also associated with changes in bile composition and gallbladder function, which may contribute to gallstone formation^{1,12}.

Vomiting was the most frequently reported symptom in the present study, occurring in 35.0% of participants, followed by fever in 25.0%, pain in 17.0% and tenderness in 6.0%. These symptoms are not specific to gallbladder disease. Gallstone disease may be asymptomatic or may present with nonspecific symptoms, making imaging particularly useful for detecting otherwise unrecognized gallbladder abnormalities⁸.

The mean fasting gallbladder volume was 31.36 ± 7.03 cc, with values ranging from 15.70 to 49.30 cc. The largest proportion of participants (34.0%) had a gallbladder volume of 30.1–35.0 cc, followed by 20.0% with a volume of 35.1–40.0 cc. Gallbladder volume was calculated using the ellipsoid method based on the maximum longitudinal, transverse and anteroposterior dimensions. This method has been shown to provide a practical approximation of gallbladder volume on ultrasonography⁹.

Diabetes may be associated with impaired gallbladder motility because of metabolic abnormalities and autonomic dysfunction. Reduced gallbladder emptying may promote bile stasis and contribute to the formation

of sludge and gallstones^{3,5}. The present study measured fasting gallbladder volume but did not evaluate gallbladder ejection fraction or postprandial emptying. Therefore, the present findings cannot establish the presence of gallbladder dysmotility.

All 100 participants had the gallbladder located in the normal gallbladder fossa, and no ectopic gallbladder was identified. A Phrygian cap was observed in 3.0% of participants. This is a recognized benign anatomical variant and is important to identify during sonographic examination to avoid confusing the folded fundus with a pathological lesion¹⁰.

Cholelithiasis was the most frequent pathological finding in the present study, occurring in 20.0% of participants. This finding is consistent with the recognized association between diabetes mellitus and gallbladder disease^{3,4}. The finding is also comparable with observations from Indian diabetic populations. Jindal et al. reported gallstones in 16% of diabetic patients compared with 5% of controls.⁷

The prevalence of cholelithiasis in the present study may differ from other populations because gallstone prevalence is influenced by age, sex, geographical location, dietary factors and metabolic characteristics^{1,6,12}. The present study also excluded obese individuals, which may have affected the observed prevalence because obesity is an established risk factor for gallstone formation¹.

The association between diabetes and gallstone formation may be explained by altered lipid metabolism and impaired gallbladder emptying. Insulin resistance may increase biliary cholesterol secretion, whereas impaired gallbladder motility may cause prolonged bile retention and facilitate stone formation⁵. The meta-analysis by Aune and Vatten reported a summary

relative risk of 1.56 for gallbladder disease among patients with diabetes, providing further epidemiological support for this association⁴.

Gallbladder sludge was detected in 11.0% of participants and was the second most common pathological finding. Biliary sludge is associated with bile stasis and may either resolve spontaneously or progress to gallstone formation⁸. Its presence in the present study may therefore be clinically relevant, although the cross-sectional design does not allow assessment of subsequent progression.

Gallbladder polyps were identified in 6.0% of participants. Polyps are frequently detected incidentally during ultrasonography. Most are benign, but some true neoplastic polyps may have malignant potential. Therefore, their detection and appropriate characterization are clinically important^{10,11}.

Adenomyomatosis was observed in 4.0% of participants. This is a benign gallbladder wall abnormality that can be identified by characteristic sonographic features. Recognition of adenomyomatosis is important because gallbladder wall abnormalities may occasionally have overlapping imaging appearances.¹⁰

Calculus cholecystitis was observed in 4.0% of participants, whereas acalculous cholecystitis was observed in 1.0%. These inflammatory abnormalities were less frequent than uncomplicated cholelithiasis. The findings demonstrate that the spectrum of gallbladder abnormalities in diabetic patients includes both calculous and non-calculous pathology.

No case of gallbladder carcinoma was detected in the present study. This finding should be interpreted in relation to the sample size of 100 participants and the relatively low frequency of gallbladder carcinoma. It

does not permit any conclusion regarding the risk of gallbladder carcinoma among diabetic patients.

Gender-wise analysis demonstrated no statistically significant association between gender and age-group distribution ($\chi^2 = 2.0122$, $p = 0.9191$). Similarly, no statistically significant association was observed between gender and gallbladder volume categories ($\chi^2 = 2.9872$, $p = 0.3941$). Thus, within the present study population, age-group distribution and gallbladder volume categories did not differ significantly between males and females.

No statistically significant association was observed between gender and the clinical symptoms evaluated. Pain, fever, vomiting and tenderness all had p-values greater than 0.05. Therefore, the clinical symptom profile did not differ significantly according to gender.

Similarly, none of the pathological findings showed a statistically significant association with gender. Cholelithiasis was numerically more common among females, with 12 cases compared with 8 cases among males, but this difference was not statistically significant ($\chi^2 = 0.362$, $p = 0.547$). Sludge was also more frequent among females than males (8 versus 3 cases), but the difference was not statistically significant ($\chi^2 = 1.745$, $p = 0.187$). Calculus cholecystitis, acalculous cholecystitis, polyps and adenomyomatosis also showed no statistically significant gender association.

Although female sex is recognized as a risk factor for gallstone disease^{1,6,12}, the absence of statistically significant gender associations in the present study may be related to the sample size and the relatively small number of participants with individual pathological abnormalities. Therefore, these findings should be interpreted within the context of the present diabetic population.

Overall, the present study demonstrated a range of sonographically detectable gallbladder abnormalities among adult patients with type II diabetes mellitus. Cholelithiasis was the most common finding, followed by sludge and polyps. Calculus cholecystitis, adenomyomatosis and acalculous cholecystitis were less frequent, while a Phrygian cap was identified as a morphological variant. The findings support the usefulness of ultrasonography for comprehensive evaluation of gallbladder morphology and pathology in adult diabetic patients.

Conclusion

Ultrasonography demonstrated a considerable burden of gallbladder abnormalities among adult patients with type II diabetes mellitus, with cholelithiasis (20.0%) being the most common finding, followed by sludge (11.0%) and polyps (6.0%). Gallbladder volume showed no significant gender-wise difference. Overall, ultrasonography is a useful non-invasive modality for detecting and characterizing gallbladder abnormalities in diabetic patients.

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