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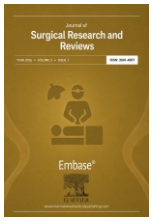

Research Article

Section: General Surgery

Comparative Evaluation of Gallstone Disease in Diabetic & Non-Diabetic Patients Undergoing Laparoscopic Cholecystectomy

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HIGHLIGHTS

- Diabetes increased surgical difficulty
- Operative time was prolonged
- Inflammation was more severe
- Xanthogranulomatous changes increased
- Diabetics had poorer outcomes

Key Words:
Gallstone disease
Diabetes mellitus
Laparoscopic cholecystectomy
Operative difficulty
Gallbladder wall thickening
Xanthogranulomatous cholecystitis
Nassar grade

ABSTRACT

Introduction: Gallstone disease is a common biliary disorder requiring surgical management, and diabetes mellitus may increase operative difficulty by causing gallbladder dysmotility, chronic inflammation, dense adhesions and associated comorbidities. **Aim & Objective:** To compare gallstone disease in diabetic and non-diabetic patients undergoing laparoscopic cholecystectomy with respect to clinical profile, ultrasonographic findings, operative difficulty, surgical outcome and histopathological changes. **Material & Methods:** This comparative cross-sectional study was conducted over 1.5 years in the Department of Surgery, Hamdard Institute of Medical Sciences and Research and associated Hakeem Abdul Hameed Centenary Hospital, New Delhi. A total of 372 adult patients with gallstone disease scheduled for laparoscopic cholecystectomy were included and divided into diabetic and non-diabetic groups, with 186 patients in each group. Clinical history, comorbidities, ultrasonographic findings, operative procedure, Nassar intraoperative grade, operative duration, recovery from anesthesia and histopathological findings were recorded and statistically analyzed. **Results:** Diabetic patients were significantly older than non-diabetic patients, with mean age of 52.24 ± 10.75 years versus 42.96 ± 11.32 years ($p<0.001$), and had a significantly higher burden of medical comorbidities ($p<0.001$). Gallbladder wall thickening was more common among diabetic patients (37 vs 16; $p<0.001$). Standard laparoscopic cholecystectomy was less frequent in diabetics, while subtotal or near-total cholecystectomy and laparoscopic-to-open conversion were higher. Diabetics also showed higher intraoperative difficulty grades, longer operative duration and delayed recovery from anesthesia. Xanthogranulomatous cholecystitis was significantly more frequent in diabetics (31 vs 9; $p<0.001$). **Conclusion:** Diabetes mellitus is associated with greater inflammatory gallbladder changes, increased operative difficulty, prolonged operative time and more severe histopathological findings in patients undergoing laparoscopic cholecystectomy.

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INTRODUCTION

Gallstone disease is one of the most common disorders of the biliary tract and remains a major cause of abdominal pain, hospital admission and surgical intervention worldwide. Gallstones are hardened deposits formed within the gallbladder or biliary tree, mainly due to imbalance in bile composition, cholesterol supersaturation, bilirubin excess and impaired gallbladder emptying [1]. They may remain silent for a long period, but once symptomatic, they can produce biliary colic, acute cholecystitis, choledocholithiasis, obstructive jaundice, cholangitis and gallstone pancreatitis. Nearly 20% of individuals with cholelithiasis may become symptomatic and develop clinically important complications requiring medical or surgical treatment [2].

The burden of gallstone disease has increased with changing dietary patterns, sedentary lifestyle, obesity, dyslipidaemia and metabolic syndrome. Classical risk factors include increasing age, female sex, obesity, pregnancy, estrogen exposure, rapid weight loss and family predisposition. In recent years, diabetes mellitus has gained particular importance as a metabolic risk factor for gallstone disease [3]. Diabetes is frequently associated with obesity, insulin resistance, hypertriglyceridaemia and hypercholesterolaemia, all of which alter bile composition and promote cholesterol stone formation. In addition, autonomic neuropathy in long-standing diabetes may impair gallbladder contraction, leading to biliary stasis and prolonged retention of lithogenic bile. Thus, diabetic patients may not only have a higher tendency to develop gallstones, but may also present with more advanced inflammatory changes when surgery is performed [4]. The relationship between diabetes mellitus & gallstone disease is clinically important because diabetes can modify both the presentation & operative course of biliary disease. Diabetic patients may have altered pain perception, delayed health-seeking behaviour, impaired immune response and poor wound healing [5].

Hyperglycaemia also promotes systemic inflammation, endothelial dysfunction and susceptibility to infection. As a result, gallbladder inflammation in diabetic patients may progress silently or present at a more advanced stage, with thickened gallbladder wall, dense adhesions, empyema, mucocele, gangrenous change or difficult Calot's triangle dissection. These factors increase the technical difficulty of laparoscopic chole-cystectomy and may prolong operative time or increase the need for subtotal cholecystectomy or conversion to open surgery [6].

Laparoscopic cholecystectomy is currently considered the preferred treatment for symptomatic gallstone disease because it offers smaller incisions, reduced postoperative pain, shorter hospital stay, faster recovery and better cosmetic outcomes compared with open cholecystectomy [7]. Guidelines and standard surgical references recognize laparoscopic cholecystectomy as the treatment of choice for most patients requiring gallbladder removal, particularly in symptomatic cholelithiasis and related biliary disease. However, the success & safety of the procedure depend on proper patient selection, adequate preoperative preparation, clear anatomical identification & the surgeon's ability to manage difficult intra-operative findings [8]. In diabetic patients, laparoscopic cholecystectomy may be more challenging because diabetes is often accompanied by multiple comorbidities such as hypertension, obesity, coronary artery disease, chronic kidney disease and dyslipidaemia [9]. These associated conditions increase anaesthetic risk and may complicate perioperative management. Poor glycaemic control can further increase the risk of infection, delayed healing and postoperative morbidity. Therefore, diabetic status is not merely a background medical condition, but an important clinical variable that can influence operative planning, intra-operative findings and postoperative outcome [10].

Several comparative studies have shown that diabetic patients undergoing laparoscopic cholecystectomy may have more difficult intra-operative findings than non-diabetic patients. Luthra et al. reported that surgery for gallstone disease in diabetic patients carries greater risk compared with non-diabetic patients, with emphasis on intraoperative difficulty during elective laparoscopic cholecystectomy [11].

Other studies have also reported higher rates of gallbladder wall thickening, adhesions and prolonged operative duration among diabetic patients. In one comparative report, adhesions and thickened gallbladder wall were significantly more frequent among diabetics, and mean operative time was longer in diabetic patients than in non-diabetic patients [12]. Earlier evidence has also suggested higher conversion rates from laparoscopic to open cholecystectomy in diabetic patients compared with non-diabetic controls [9].

Gallbladder wall thickness is an important radiological and operative marker in gallstone disease. Ultrasonographic evidence of wall thickening often reflects chronic inflammation, oedema, fibrosis or acute cholecystitis [13]. A thickened gallbladder wall can make grasping and retraction difficult, obscure tissue planes and increase the risk of bleeding or bile duct injury during dissection. Studies evaluating gallbladder wall thickness have noted its relevance as an indicator of cholecystitis among patients presenting with symptomatic gallstone disease [14]. In diabetic patients, persistent low-grade inflammation and delayed presentation may contribute to more severe wall thickening and dense pericholecystic adhesions, thereby increasing the likelihood of a difficult laparoscopic procedure [15].

Histopathological assessment after cholecystectomy helps identify the severity & chronicity of gallbladder disease, including chronic cholecystitis, acute-on-chronic inflammation, cholesterolosis and xanthogranulomatous cholecystitis. Xanthogranulomatous cholecystitis is especially important because it causes marked wall thickening, fibrosis and adhesions, increasing operative difficulty and sometimes mimicking malignancy [16]. In diabetic patients, such changes may reflect repeated subclinical attacks, delayed presentation and altered inflammatory response. Therefore, comparing diabetic & non-diabetic patients undergoing laparoscopic cholecystectomy is clinically relevant for assessing comorbidities, ultrasonographic changes, intra-

operative difficulty, operative time and recovery, thereby improving preoperative planning, patient counselling & surgical prepare-dness [17].

Figure. 1. Proposed mechanistic pathways linking diabetes mellitus to increased operative difficulty during laparoscopic cholecystectomy.

The present study aims to compare intra-operative difficulty and surgical outcomes between diabetic and non-diabetic patients undergoing laparoscopic cholecystectomy for gallstone disease. It evaluates Nassar operative difficulty grade, duration of surgery, conversion to open surgery or subtotal cholecystectomy, and gallbladder histopathology to determine the influence of diabetes mellitus on operative complexity, surgical decision-making and pathological changes.

MATERIALS & METHODS

This comparative cross-sectional study was conducted over 1.5 years in the Department of Surgery, Hamdard Institute of Medical Sciences and Research and associated Hakeem Abdul Hameed Centenary Hospital, New Delhi. Adult patients above 18 years diagnosed with gallstone disease and scheduled for laparoscopic cholecystectomy were included after written informed consent. Patients below 18 years, those with acute cholecystitis, choledo-cholithiasis, gallstone-induced pancreatitis, or unwillingness to participate were excluded. Participants were divided into diabetic and non-diabetic groups. Clinical profile, ultrasonographic findings, operative difficulty, surgical outcome & histo-pathological findings were recorded, while confidentiality and ethical protocols were maintained.

Table 1: Baseline Characteristics and Past History among DM and Non-DM Patients

Main interest	Variable/category	DM group, n = 186	Non-DM group, n = 186	Test applied	Test value	p-value
Age	Age in years, Mean ± SD	52.24 ± 10.75	42.96 ± 11.32	Welch's independent t-test	7.80	<0.001
Gender	Female	156	138	Chi-square test	6.62	0.01
	Male	30	48			
BMI	BMI, kg/m², Mean ± SD	25.61 ± 4.47	24.13 ± 13.49	Welch's independent t-test	1.41	0.16
Comorbidities	**Medical comorbidities, subtotal**	**91**	**27**	Chi-square test	96.4*	<0.001*
	Hypertension	69	8			
	Hypothyroidism	18	6			
	Hypertension with hypothyroidism	17	3			
	Other medical comorbidities: COPD, depression, asthma, tuberculosis and CAD	13	10			
	History of surgery, subtotal	**9**	**13**			
	ERCP	6	9			
	Other previous surgeries: LSCS, appendectomy, tubectomy and incision and drainage	3	4			
	Total	**186**	**186**			

Table 2: History of acute cholecystitis and recurrent biliary

Main interest	Variable	DM n = 186	Non-DM n = 186	Test applied	p-value
H/O acute cholecystitis	Yes	58	30	Chi-square test	0.05
H/O recurrent biliary colic	Yes	47	33	Chi-square test	0.10

Table 3: USG findings

Main interest	USG parameter	Sub-category	DM n = 186	Non-DM n = 186	p-value
USG finding	Gallbladder status	Distended	168	172	0.42
		Contracted	18	14	0.42
	Type of calculus	Single / solitary	74	68	0.06
		Multiple	96	118	0.06
	GB wall thickness	Normal / thin	149	170	<0.001
		Thickened and edematous	37	16	<0.001
	Biliary channel / CBD	Normal	183	184	0.65
		Dilated	3	2	0.65

Table 4: Operative findings and outcomes

Main variable	Category	DM group, n = 186	Non-DM group, n = 186	Test applied	Test value	p-value
Surgical procedure	Standard laparoscopic cholecystectomy	151	174	Pearson chi -square test, overall	12.89	0.002
	Subtotal/near -total laparoscopic cholecystectomy	23	8			
	Conversion to open surgery	12	4			
Nassar intra-operative grade	Grade I	85	129	Pearson chi -square test, overall	21.43	<0.001
	Grade II	47	28			
	Grade III	31	16			
	Grade IV	23	13			
Duration of surgery	Operative duration in minutes, Mean ± SD	57.51 ± 38.86	43.47 ± 45.37	Welch's independent t -test	3.19	0.002
Recovery from anaesthesia	Recovery time in minutes, Mean ± SD	93.84 ± 39.72	74.28 ± 46.15	Welch's independent t -test	4.38	<0.001

Table 5: HPE findings

Main interest	HPE finding	DM n = 186	Non-DM n = 186	Test value	p-value
HPE	Chronic cholecystitis with cholelithiasis	148	174	14.44	<0.001
	Xanthogranulomatous cholecystitis	31	9	12.35	<0.001
	Chronic cholecystitis with cholesterolosis	7	3	0.92	0.34
	Total	186	186		

RESULTS

Diabetic patients were significantly older than non-diabetic patients, with mean ages of 52.24 ± 10.75 years and 42.96 ± 11.32 years, respectively (p<0.001). Gender distribution also differed significantly between the two groups (p=0.01), whereas the difference in mean BMI was not statistically significant (p=0.16). Medical comorbidities were significantly more frequent among diabetic patients, particularly hypertension and hypothyroidism (p<0.001). These findings indicate that diabetic patients had a greater burden of baseline medical comorbidities before undergoing laparoscopic cholecystectomy **(Table 1)**.

In the present table, history of acute cholecystitis was more common in diabetic patients than non-diabetic patients 58 vs 30, with borderline statistical significance p=0.05. Recurrent biliary colic was also higher among diabetics 47 vs 33, but this difference was not statistically significant p=0.10. These findings suggest that diabetic patients had a greater tendency toward previous inflammatory biliary events before laparoscopic cholecystectomy **(Table 2)**. In the present table, gallbladder status and CBD findings were comparable between diabetic and non-diabetic patients, with no significant difference p=0.42 and p=0.65. Type of calculus showed only a near-significant difference p=0.06. However,

thickened and edematous gallbladder wall was significantly more frequent in diabetics 37 vs 16, p<0.001. This suggests greater inflammatory gallbladder changes among diabetic patients on USG **(Table 3)**. Compared with the control group, diabetic patients had significantly fewer standard laparoscopic cholecystectomies and a higher need for subtotal or near-total procedures (p<0.001 and p=0.01, respectively). Higher intraoperative grades were more frequent in diabetics, especially Grade 2 and Grade 3 cases. Conversion to open surgery was higher in diabetics, 12 versus 4, though not statistically significant (p=0.07). Longer operative duration and recovery time in diabetics indicate greater operative difficulty and delayed perioperative recovery **(Table 4)**.

In the present table, chronic cholecystitis with cholelithiasis was significantly more frequent in non-diabetic patients 174 vs 148, p<0.001. In contrast, xanthogranulomatous cholecystitis was markedly higher among diabetic patients 31 vs 9, p<0.001, suggesting more severe inflammatory pathology. Chronic cholecystitis with cholesterolosis showed no significant difference p=0.34. Overall, HPE findings indicate more aggressive gallbladder inflammation in diabetic patients **(Table 5)**.

DISCUSSION

In the present study, diabetic patients with gallstone disease showed a distinct clinico-operative profile when compared with non-diabetic patients. The diabetic group was significantly older than the non-diabetic group, with mean age of 52.24 ± 10.75 years versus 42.96 ± 11.32 years, respectively, and this difference was statistically significant ($p < 0.001$). Female predominance was observed in both groups, but it was more marked among diabetics, with 156 females in the diabetic group compared with 138 females in the non-diabetic group ($p = 0.01$). BMI was slightly higher in diabetics, 25.61 ± 4.47 kg/m², than non-diabetics, 24.13 ± 13.49 kg/m², but the difference was not statistically significant ($p = 0.16$). These findings are supported by Sodhi JS et al. [18], who reported that type 2 diabetes was significantly associated with gallstone disease and that age, female sex and BMI were important independent predictors of gallstone formation. Similarly, Sari Ö and Bashir AM [19] observed female predominance and a high burden of impaired glucose metabolism among patients with gallbladder disease. In our study, past medical history was significantly more frequent among diabetics, especially hypertension, hypothyroidism and combined medical disorders, with overall association being highly significant ($\chi^2 = 96.4$; $p < 0.001$), supporting the concept that diabetic gallstone patients often present with a higher metabolic and comorbidity burden. A history of acute cholecystitis was more common in diabetic patients than non-diabetics, 58 versus 30 cases, with borderline statistical significance ($p = 0.05$), while recurrent biliary colic was also more frequent among diabetics, 47 versus 33 cases, though not statistically significant ($p = 0.10$). This suggests that diabetes may be associated with more inflammatory gallbladder disease, although recurrent biliary symptoms may not always differ significantly between groups. On ultrasonography, gallbladder distension and contracted gallbladder status were comparable between groups, and the distribution of single and multiple calculi did not reach statistical significance. However, gallbladder wall thickening was significantly higher among diabetics, 37 cases, compared with non-diabetics, 16 cases ($p < 0.001$). This finding correlates well with Sari Ö and Bashir AM [19], who found significantly increased gallbladder wall thickening in diabetic and prediabetic patients, and with Dhivya KP et al. [20], who demonstrated impaired gallbladder volume and contraction index in diabetics, particularly in relation to autonomic neuropathy. Operative findings further confirmed greater surgical difficulty among diabetic patients.

Standard laparoscopic cholecystectomy was performed less frequently in diabetics, 151 cases, than non-diabetics, 174 cases, while subtotal or near-total laparoscopic cholecystectomy was more common in diabetics, 23 versus 8 cases ($p = 0.01$). Laparoscopic to open conversion was also higher in diabetics, 12 versus 4 cases, and conversion to open surgery showed a clinically important trend ($p = 0.07$). Higher intra-operative grades were more frequent in diabetics, with Grade 2 and Grade 3 being significantly increased, indicating more difficult dissec-tion. Luthra A et al. [11] similarly reported that diabetic patients undergoing elective laparoscopic cholecystectomy had more thickened gallbladder walls, dense adhesions, greater operative difficulty, increased need for subtotal cholecystectomy and higher conversion rates. Turki M et al. [21] also found signific-antly higher conversion to open surgery in diabetics, 16.7% versus 2.1%, and longer postoperative hospital stay.

In our study, operative duration was significantly longer in diabetics, 57.51 ± 38.86 minutes, compared with non-diabetics, 43.47 ± 45.37 minutes ($p = 0.002$), and recovery from anesthesia was also prolonged, 93.84 ± 39.72 minutes versus 74.28 ± 46.15 minutes ($p < 0.001$), reflecting increased operative and peri-anesthetic complexity.

Histopathological findings showed that chronic cholecystitis with cholelithiasis was present in both groups but was proportio-nally more frequent in non-diabetics, whereas xanthogranulo-matous cholecystitis was markedly higher among diabetics, 31 cases, compared with 9 cases in non-diabetics ($p < 0.001$). Chronic cholecystitis with cholesterolosis showed no significant difference ($p = 0.34$). These findings support the pathological basis that diabetes is associated with chronic inflammation, fibrosis, impaired immunity and more advanced gallbladder pathology. Overall, our results indicate that diabetic patients with gallstone disease are older, have more comorbidities, show more gallbladder wall thickening, experience greater operative difficulty, require more subtotal or converted procedures and demonstrate more severe histopathological changes than non-diabetic patients.

CONCLUSION

This study concludes that diabetes mellitus significantly increases operative difficulty and prolongs operative time during laparo-scopic cholecystectomy. Diabetic patients were generally older,

had poorer glycaemic control and showed a higher burden of associated comorbidities than non-diabetic patients. Greater surgical difficulty was evident from higher Nassar grades, longer operative duration, & increased need for subtotal cholecystectomy or conversion to open surgery. Ultrasonography commonly showed gallbladder wall thickening, while histopathology more frequently revealed xanthogranulomatous cholecystitis, suggesting severe inflammation and fibrosis. These changes were associated with poor glycaemic control and longer diabetes duration, emphasizing the need for careful planning and preoperative optimization.

LIMITATIONS & FUTURE PERSPECTIVES

The study's limitations include a single-centre setting, a relatively small sample size, and a short study duration, which may limit the broader applicability of the results. Future studies should incorporate multicentre designs with larger populations to enhance validity, assess long-term outcomes, and investigate advanced diagnostic & management approaches. Such efforts will improve overall patient care & help minimize complications.

CLINICAL SIGNIFICANCE

The clinical significance of this study lies in its potential to bridge the gap between research findings and practical healthcare, diagnosis, and treatment outcomes. By highlighting real-care applications. It emphasizes the importance of translating scientific observations into meaningful improvements in patient world relevance, the study contributes to evidence based medical practice and supports informed clinical decision making. Ultimately, the findings aim to enhance patient quality of life, optimize therapeutic strategies, and promote better disease management in clinical settings.

ABBREVIATIONS

DM: Diabetes Mellitus
LC: Laparoscopic Cholecystectomy
XGC: Xanthogranulomatous Cholecystitis
USG: Ultrasonography
Nassar Grade: Nassar Intraoperative Difficulty Grade

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AUTHOR CONTRIBUTIONS

All authors significantly contributed to the study conception and design, data acquisition, or data analysis and interpretation. They participated in drafting the manuscript or critically revising it for important intellectual content, consented to its submission to the current journal, provided final approval for the version to be published, and accepted responsibility for all aspects of the work. Additionally, all authors meet the authorship criteria outlined by the International Committee of Medical Journal Editors (ICMJE) guidelines.

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CONFLICT OF INTEREST

Authors declared that there is no conflict of interest.

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None

ETHICAL APPROVAL & CONSENT TO PARTICIPATE

All necessary consent & approval was obtained by authors.

CONSENT FOR PUBLICATION

All necessary consent for publication was obtained by authors.

DATA AVAILABILITY

All data generated and analyzed are included within this research article. The datasets utilized and/or analyzed in this study can be obtained from the corresponding author upon a reasonable request.

USE OF ARTIFICIAL INTELLIGENCE (AI) & LARGE LANGUAGE MODEL (LLM)

The authors confirm that no AI & LLM tools were used in the writing or editing of the manuscript, and no images were altered or manipulated using AI & LLM.

AUTHOR'S NOTE

This article serves as an important educational tool for the scientific community, offering insights that may inspire future research directions. However, they should not be relied upon independently when making treatment decisions or developing public health policies.

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