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DIAGNOSTIC EVALUATION OF GANGRENOUS CHOLECYSTITIS ON ULTRASOUND AND CONTRAST ENHANCED COMPUTED TOMOGRAPHY

Original Research

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ABSTRACT

Background: Gangrenous cholecystitis (GC) is a life-threatening complication of acute cholecystitis, characterized by gallbladder wall ischemia and necrosis. If not promptly diagnosed and treated, GC can result in perforation, peritonitis, and significantly increased mortality. Early and accurate identification through imaging is essential for effective clinical decision-making and timely surgical intervention, particularly in patients presenting with complicated gallbladder pathologies.

Objective: To assess the diagnostic accuracy of ultrasound (USG) and contrast-enhanced computed tomography (CECT) in detecting gangrenous cholecystitis preoperatively and to identify associated clinical and imaging findings.

Methods: A cross-sectional analytical study was conducted from January to April 2025 at Punjab Radiology, Jail Road, Lahore, Pakistan. Sixty-four patients aged 25 to 77 years (mean age: 50.08) with suspected complicated gallbladder conditions were enrolled using convenience sampling. Data were collected retrospectively from hospital records and analyzed using SPSS version 26. Each patient underwent either USG (n=38) or CECT (n=26) before surgery. Postoperative diagnoses were compared with imaging results to evaluate diagnostic performance. Chi-square and Fisher's exact tests were applied to determine statistical significance.

Results: Out of 64 patients, 44 (68.8%) were diagnosed with GC postoperatively, with a higher frequency in males (54.5%). CECT demonstrated higher sensitivity (83.3%), specificity (85.7%), and overall accuracy (84.6%) compared to USG (sensitivity: 59.4%, specificity: 66.7%, accuracy: 60.5%). A statistically significant correlation was observed between CECT findings and postoperative diagnosis ($p = 0.001$), unlike USG ($p = 0.239$). Common symptoms were abdominal pain (57.8%), nausea (25%), and vomiting (23%). Imaging revealed thickened GB walls in 79.7%, irregular walls in 71.9%, calculi in 68.8%, and pericholecystic fluid in 53.1%. One patient (1.6%) developed perforation due to delayed treatment.

Conclusion: CECT is a more accurate and reliable imaging modality than ultrasound for the preoperative detection of gangrenous cholecystitis and should be considered in patients with high clinical suspicion.

Keywords: Cholelithiasis, Contrast-enhanced computed tomography, Diagnostic evaluation, Gangrenous cholecystitis, Ischemia, Perforation, Ultrasound.

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INTRODUCTION

Gangrenous cholecystitis (GC) is a rare yet severe complication of acute cholecystitis, associated with significant morbidity and mortality if not diagnosed and managed promptly (1). It typically develops as a consequence of untreated or prolonged inflammation of the gallbladder, commonly triggered by obstruction of the cystic duct, most often due to a gallstone (2). This obstruction leads to bile stasis and gallbladder distension, promoting inflammation that can progress to ischemia and necrosis of the gallbladder wall due to compromised vascular supply (3). In advanced cases, this pathological progression may result in wall perforation, abscess formation, peritonitis, sepsis, and multi-organ failure (4). Despite its clinical significance, GC remains challenging to diagnose owing to its often-nonspecific presentation and the overlap of symptoms with uncomplicated cholecystitis, such as upper abdominal pain, nausea, vomiting, and fever (5). The pathogenesis of GC is intricately linked to cystic duct obstruction, leading to increased intraluminal pressure, impaired blood flow, and subsequent ischemic injury. Ischemia makes the gallbladder wall vulnerable to bacterial invasion, exacerbating inflammation and accelerating tissue necrosis. Systemic inflammatory responses triggered by necrotic tissue can further complicate the clinical course (6). Timely diagnosis is critical as delayed recognition can lead to irreversible complications, necessitating open surgical intervention or percutaneous drainage in high-risk patients not suitable for surgery (7). However, the diagnostic process remains hampered by the absence of definitive clinical or laboratory markers, making imaging an indispensable component in identifying GC (8).

Currently, hepatobiliary scintigraphy (HIDA scan) is regarded as the gold standard for diagnosing cholecystitis due to its high sensitivity and specificity; however, its limited availability, cost, and time-intensive nature restrict its routine use in emergency settings (9). Ultrasound is typically the first-line imaging modality for suspected biliary pathology due to its accessibility and non-invasive nature, but its specificity for GC is relatively modest, reported around 76% (10). In contrast, contrast-enhanced computed tomography (CECT) offers superior specificity and can provide valuable insights when ultrasound findings are inconclusive, especially in detecting features such as wall thickening, intraluminal gas, and pericholecystic collections that may suggest GC (10,11). Yet, despite this potential, comparative evidence between ultrasound and CECT in the context of GC remains sparse. Risk factors such as older age, male sex, obesity, leukocytosis, and fever are often associated with the development of GC (12). Imaging features like irregular gallbladder wall thickening, mucosal sloughing, or pericholecystic fluid collections can raise suspicion, but these signs are neither definitive nor consistently present. Furthermore, literature on GC and related entities such as emphysematous cholecystitis is largely limited to single-patient case reports or small series, restricting broader clinical understanding (13). The lack of adequately powered studies with representative patient populations has contributed to persistent knowledge gaps, particularly in standardizing diagnostic strategies and optimizing treatment algorithms for GC. Given these limitations, there is a pressing need for robust clinical research to determine the diagnostic performance of commonly used imaging modalities. This study is therefore designed to evaluate the diagnostic accuracy, sensitivity, and specificity of ultrasound and contrast-enhanced computed tomography in detecting gangrenous cholecystitis, while also identifying the most frequent clinical and radiological findings. The ultimate aim is to support timely and accurate diagnosis, thereby facilitating improved clinical decision-making and enhancing patient outcomes

METHODS

A cross-sectional analytical study was conducted at Punjab Centre, Lahore, Pakistan, to evaluate the diagnostic performance of contrast-enhanced computed tomography (CECT) versus ultrasound (USG) in identifying gangrenous cholecystitis. The study included a total of 64 patients presenting with complicated gallbladder pathologies where GC was clinically suspected. Participants were selected through a non-probability convenience sampling method, and data were retrieved from institutional hospital records following approval by the relevant ethical committee. Only patients aged 18 years and above were included, while those under 18 were excluded to ensure appropriate clinical and radiological interpretation in an adult population. Among the included patients, 31 were male (48.4%) and 33 were female (51.6%), with a mean age of 50.08 years (range 25–77 years) (3,4). All participants underwent imaging via both CECT and USG for evaluation. The imaging was conducted prior to surgical exploration or pathological confirmation, and both radiological modalities were interpreted by trained radiologists who were blinded to the other modality's findings to reduce interpretation bias. The

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criteria for diagnosing gangrenous cholecystitis were based on previously established imaging findings suggestive of necrosis, wall irregularity, intraluminal membranes, and pericholecystic fluid collections.

Data collection was supported by institutional medical records, and informed consent was presumed or obtained from patients during the clinical diagnostic work-up process. The study was approved by the institutional review board (IRB). Data analysis was performed using the Statistical Package for the Social Sciences (SPSS), version 26. Categorical variables were expressed as frequencies and percentages, while continuous variables were described using means and standard deviations. Diagnostic performance parameters—sensitivity, specificity, and overall diagnostic accuracy—were calculated for both imaging modalities, and hypothesis testing was carried out using appropriate statistical methods to assess differences in diagnostic capabilities.

RESULTS

A total of 64 patients with suspected gangrenous cholecystitis were included in the study. The sample comprised 33 females (51.6%) and 31 males (48.4%), with a mean age of 50.08 years and an age range of 25 to 77 years. The most represented age group was 38–50 years, accounting for 32.81% of the study population, followed by 51–63 years (26.56%), 64–77 years (21.87%), and 25–37 years (18.75%). Out of the total participants, 38 underwent ultrasonography (USG) and 26 underwent contrast-enhanced computed tomography (CECT). Postoperative diagnosis confirmed gangrenous cholecystitis in 44 patients (68.8%), with a greater proportion in males (54.5%). Six patients (9.37%) were diagnosed with gallbladder carcinoma and did not undergo immediate surgical intervention. Fourteen cases (21.9%) were diagnosed as non-gangrenous cholecystitis following surgery. When imaging findings were compared with surgical outcomes, CECT correctly identified gangrene in 10 of 12 confirmed cases, yielding a sensitivity of 83.3%, specificity of 85.7%, and an overall diagnostic accuracy of 84.6%. In comparison, USG identified 19 of 32 gangrenous cases, with a sensitivity of 59.4%, specificity of 66.7%, and an overall accuracy of 60.5%. Statistical analysis revealed a significant association between CECT findings and postoperative diagnosis of gangrenous cholecystitis ($p = 0.001$), while the association between USG findings and surgical diagnosis was not statistically significant ($p = 0.239$). This indicates that CECT was a more reliable imaging modality for preoperative detection of gangrenous changes in the gallbladder.

Symptomatically, 16 patients (25%) presented with nausea, 15 (23.4%) with vomiting, and 37 (57.8%) experienced abdominal pain. On imaging, thickened gallbladder walls (>3 mm) were the most common finding, observed in 51 patients (79.7%), followed by irregular walls in 46 patients (71.9%), gallstones in 44 (68.8%), and marked distension of the gallbladder in 38 (59.4%). Additional findings included pericholecystic fluid in 34 patients (53.1%), intraluminal air in 34 (53.1%), biliary sludge in 18 (28.1%), sloughed mucosa in 9 (14.1%), masses in 9 (14.1%), and polyps in 3 (4.7%). One case (1.6%) developed perforation and peritonitis due to delayed treatment. The chi-square analysis provided additional insights into the association between specific imaging and clinical features and the presence of gangrenous cholecystitis. A statistically significant relationship was observed between thickened gallbladder walls and the diagnosis of gangrenous cholecystitis ($p = 0.0029$), indicating its strong predictive value in clinical assessment. Other features such as irregular gallbladder walls ($p = 0.0846$), intraluminal air ($p = 0.0669$), and sloughed mucosa ($p = 0.0875$) approached statistical significance but did not meet the conventional threshold, suggesting a potential association that may require a larger sample size for confirmation. Conversely, findings like the presence of calculi ($p = 0.4671$), biliary sludge ($p = 0.4998$), and gallbladder polyps ($p = 1.000$) did not show any statistically meaningful relationship with gangrenous transformation. These results underscore the importance of wall thickening as a reliable imaging indicator of GC and highlight the need for comprehensive radiological assessment when gangrene is suspected.

Table 1: Demographic Distribution of Study Participants by Gender and Age Group

Gender	Frequency	Percent	Age Group	Frequency	Percentage
Female	33	51.6%	25–37	12	18.75%
Male	31	48.4%	38–50	21	32.81%
Total	64	100.0%	51–63	17	26.56%
			64–77	14	21.87%

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Table 2: Post-Operative Diagnosis (Gender Cross tabulation)

Count				
		Gender		Total
		F	M	
Post-Operative Diagnosis	GANGRENOUS	20	24	44
	GB CANCER	5	1	6
	NON-GANGRENOUS	8	6	14
Total		33	31	64

Table 3: Imaging Findings, Post-Operative Diagnosis, Modality (USG/CT) Cross tabulation

Count						
Modality (USG/CT)			Post-Operative Diagnosis			Total
			GANGRENOUS	N/A GB CA	NO GANGRENE	
USG	Imaging Findings	GANGRENOUS	19	N/A	2	21
		NO GANGRENE	13	N/A	4	17
	Total		32	N/A	6	38
CT	Imaging Findings	GANGRENOUS	10	2	0	12
		NO GANGRENE	2	4	8	14
	Total		12	6	8	26
Total	Imaging Findings	GANGRENOUS	29	2	2	33
		NO GANGRENE	15	4	12	31
	Total		44	6	14	64

Table 4: Chi-Square and Fisher's Exact Test Results for Association Between Imaging Modality (USG/CECT) and Postoperative Diagnosis of Gangrenous Cholecystitis

Modality (USG/CT)		Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
USG	Pearson Chi-Square	1.386[b]	1	.239	.378	.233
	Continuity Correction	.533	1	.465		
	Likelihood Ratio	1.389	1	.238	.378	.233
	Fisher's Exact Test				.378	.233
	N of Valid Cases	38				
CT	Pearson Chi-Square	13.929[d]	2	.001	.000	
	Likelihood Ratio	17.438	2	.000	.000	
	Fisher's Exact Test	14.382			.000	
	N of Valid Cases	26				
Total	Pearson Chi-Square	12.213[a]	2	.002	.001	
	Likelihood Ratio	13.075	2	.001	.002	
	Fisher's Exact Test	12.326			.001	
	N of Valid Cases	64				

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is 2.91.

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Modality (USG/CT)	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
b. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 2.68.					
c. Computed only for a 2x2 table					
d. 4 cells (66.7%) have expected count less than 5. The minimum expected count is 2.77.					

Table 5: Comparative Statistical Analysis of Ultrasound and Contrast-Enhanced Computed Tomography for Preoperative Diagnosis of Gangrenous Cholecystitis

Modality	Statistic	Value	df	p-value (2-sided)	Fisher's Exact Test (2-sided)	Interpretation	Valid Cases
USG	Pearson Chi-Square	1.386	1	0.239	0.378	Not Significant	38
	Continuity Correction	0.533	1	0.465	—	—	—
	Likelihood Ratio	1.389	1	0.238	0.378	Not Significant	—
CECT	Pearson Chi-Square	13.929	2	0.001	0.000	Significant	26
	Likelihood Ratio	17.438	2	0.000	0.000	Highly Significant	—
	Fisher's Exact Test	14.382	—	—	0.000	Significant	—

Table 6: Frequency Distribution of Symptoms and Imaging Findings Among Patients with Suspected Gangrenous Cholecystitis

		Responses		Percent of Cases
		N	Percent	
Symptoms and Imaging Findings	Nausea	16	4.5%	25.0%
	Vomiting	15	4.2%	23.4%
	Abdominal Pain	37	10.4%	57.8%
	Marked distension of GB	38	10.7%	59.4%
	Thickened GB walls	51	14.4%	79.7%
	Irregular Walls	46	13.0%	71.9%
	Calcului	44	12.4%	68.8%
	GB Sludge	18	5.1%	28.1%
	Polyps	3	0.8%	4.7%
	Mass	9	2.5%	14.1%
	Pericholecystic Fluid	34	9.6%	53.1%
	Perforation	1	0.3%	1.6%
	Sloughed Mucosa	9	2.5%	14.1%
	Intraluminal Air	34	9.6%	53.1%
Total		355	100.0%	554.7%

Table 7: Chi-Square Test for GC Findings

Feature	GC Present	Non-GC Present	Chi-square	p-value
Thickened GB wall	40	11	8.85	0.0029
Irregular GB wall	35	11	2.97	0.0846
Calculi	32	12	0.53	0.4671
GB Sludge	14	4	0.46	0.4998
Polyps	2	1	0	1
Mass	7	2	0.06	0.8085
Pericholecystic fluid	26	8	1.32	0.2508
Sloughed mucosa	8	1	1.04	0.3086

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Feature	GC Present	Non-GC Present	Chi-square	p-value
Intraluminal air	28	6	4.97	0.0258

Figure 1 Symptoms and Imaging Findings Frequency

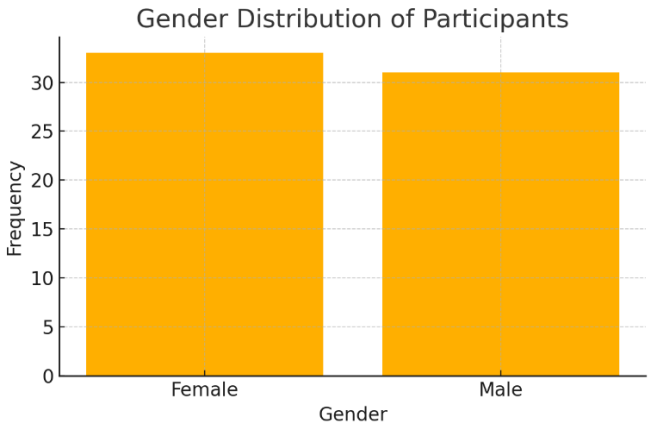

Figure 2 Gender Distribution of Participants

DISCUSSION

The findings of this study reinforce the clinical significance of using contrast-enhanced computed tomography (CECT) for the preoperative diagnosis of gangrenous cholecystitis (GC), particularly in complex or ambiguous cases. With a sensitivity of 83.3%, specificity of 85.7%, and overall diagnostic accuracy of 84.6%, CECT outperformed ultrasound (USG), which demonstrated a lower sensitivity of 59.4%, specificity of 66.7%, and overall accuracy of 60.5% (14). These results highlight the superior diagnostic value of CECT in detecting necrotic changes, particularly in the presence of gas and sloughed mucosa, which may obscure USG findings. Statistical analysis further substantiated the significance of CECT, showing strong correlation with postoperative findings ($p = 0.001$), unlike USG, which did not reach statistical significance ($p = 0.239$) (15). These findings are consistent with previously published reports where CT imaging showed superior diagnostic parameters compared to ultrasound for detecting cholecystitis and its complications. In some prior studies, CT was reported to have sensitivities ranging from 81% to 85%, while ultrasound exhibited varying sensitivity between 37.9% and 68% in detecting acute or gangrenous cholecystitis (16,17). These comparative outcomes confirm that CT has a reliable edge in visualizing critical pathological features such as wall thickening, intraluminal membranes, and air foci, which are often either missed or poorly visualized on USG. Although USG remains a primary modality due to its accessibility and cost-effectiveness, its limitations become apparent in advanced disease states such as GC where echogenic disruption and bowel gas can hinder visualization (18). An important epidemiological observation in this study was the higher prevalence of GC in male patients, despite the overall female predominance in gallbladder pathologies. Male patients accounted for 55% of GC cases, aligning with evidence from earlier research suggesting a higher tendency for gallbladder necrosis in males. This gender disparity could be attributed to delayed healthcare-seeking behavior, hormonal influences, or anatomical and vascular differences contributing to a more aggressive disease course in males (19). The most frequently observed imaging findings in GC cases included gallbladder wall thickening, irregular contour, marked distension, intraluminal air, and pericholecystic fluid. These are well-established radiological markers of necrosis and severe inflammation, and their high occurrence rate in the study further strengthens their diagnostic utility (20).

The strength of this study lies in its comparative design, which allowed direct evaluation of both USG and CECT against Histopathologically confirmed cases of GC. The use of validated statistical tools such as chi-square and Fisher's exact tests provided robust evidence of diagnostic accuracy. Additionally, the study provided a detailed breakdown of symptom frequencies and associated imaging patterns, offering a valuable profile of typical GC presentations. However, several limitations affect the generalizability of the findings. The sample size was relatively small and drawn from a single center, limiting the diversity of the population studied. The research was conducted under constraints of time and resources, restricting inclusion to adult patients with complicated gallbladder presentations, which may not reflect the broader population spectrum. Also, the study did not include an assessment of inter-observer variability, which could have provided insight into diagnostic consistency across radiologists. Future research should focus on larger multicenter cohorts with inclusion of both early and atypical presentations of GC. Incorporating advanced imaging analytics or scoring

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systems to stratify GC risk preoperatively may improve early intervention and patient outcomes. Comparative studies evaluating combinations of imaging findings, laboratory markers, and clinical symptoms could also refine diagnostic protocols. Despite limitations, the current findings underscore the diagnostic value of CECT and affirm its essential role in the timely management of gangrenous cholecystitis, potentially reducing the risk of perforation, sepsis, and mortality when integrated into routine diagnostic algorithms.

CONCLUSION

This study concludes that contrast-enhanced computed tomography is a more effective and dependable imaging tool than ultrasound for the preoperative diagnosis of gangrenous cholecystitis. By offering clearer visualization of critical pathological features, CECT enables earlier and more accurate identification of this life-threatening condition, facilitating timely surgical intervention and improving patient outcomes. While ultrasound remains useful as an initial diagnostic approach, its limited specificity in complicated cases underscores the need for incorporating CECT into diagnostic protocols, particularly when gangrene is suspected. The findings emphasize the importance of selecting appropriate imaging modalities to support clinical decision-making and reduce the risk of complications associated with delayed diagnosis.

AUTHOR CONTRIBUTION

Author	Contribution
Zarnab Ali	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Loqman Shah*	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Aizaz Hassan	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Muhammad Shahzad	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Saja Irfan	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Hamna Fatima	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Hareem Khadim	Contributed to study concept and Data collection Has given Final Approval of the version to be published
Malika Younas	Writing - Review & Editing, Assistance with Data Curation

REFERENCES

1. Martínez-Chamorro E, Ibáñez L, Navallas M, Navas I, Cambra F, Gónzalez-Serrano M, et al. Acute cholecystitis in recent lung transplant patients: a single-institution series of 10 cases. Abdom Radiol (NY). 2021;46(8):3855-65.
2. Aleman Espino E, Kazaleh M, Zaglul J, Frontela O. Acute Cholecystitis Presenting With Atypical Radiologic or Laboratory Findings: A Case Report. Cureus. 2023;15(6):e41217.

3. Lahham EE, Ghweir AA, Alsalah QA, Alsahouri MI, AlQadi M. A Case of Asymptomatic Perforated Gangrenous Cholecystitis in a Diabetic Patient: A Critical Condition. Cureus. 2023;15(10):e48014.
4. Bakri K, Abu-Shaban K, Doddi S, Liu X, Begeman GA. Distinguishing Between Gangrenous Cholecystitis and Ascending Cholangitis: A Case Study. Cureus. 2022;14(8):e28322.
5. Tse JR, Gologorsky R, Shen L, Bingham DB, Jeffrey RB, Kamaya A. Evaluation of early sonographic predictors of gangrenous cholecystitis: mucosal discontinuity and echogenic pericholecystic fat. Abdom Radiol (NY). 2022;47(3):1061-70.
6. Muenyi CS, Zalamea NN, Dhindsa P, Miller MP, Foretia DA. Gallbladder volvulus with gangrenous cholecystitis - A case report. Int J Surg Case Rep. 2022;97:107468.
7. Parza K, Patel P, Scibelli N, Sansbury JR. Occult Perforated Gangrenous Gallbladder Found on Magnetic Resonance Cholangiopancreatography. Cureus. 2021;13(6):e15754.
8. Tokuda A, Maehira H, Iida H, Mori H, Nitta N, Maekawa T, et al. Pleural empyema caused by dropped gallstones after laparoscopic cholecystectomy for acute cholecystitis: a case report. Surg Case Rep. 2022;8(1):62.
9. V K, Pushpaketu N, Badhai S, Mishra A, Sahu S, Debata I, et al. Risk Factors Associated With Gangrenous Cholecystitis: A Cohort Study From Eastern India. Cureus. 2024;16(11):e74126.
10. Liu Y, Xue D, Peng Y. The Value of Ultrasonography in Predicting Acute Gangrenous Cholecystitis. Curr Med Imaging. 2022;18(12):1257-60.
11. Romero-Velez G, Pereira X, Mandujano CC, Parides MK, Muscarella P, Melvin WS, Love C, McAuliffe JC. The Utility of Hepatobiliary Scintigraphy Scans in the Tokyo Guidelines Era for Acute Cholecystitis. Journal of Surgical Research. 2021 Dec 1;268:667-72.
12. Schuster KM, Schroeppel TJ, O'Connor R, Enniss TM, Cripps M, Cullinane DC, Kaafarani HM, Crandall M, Puri R, Tominaga GT. Imaging acute cholecystitis, one test is enough. The American Journal of Surgery. 2023 Jul 1;226(1):99-103.
13. Fabbri N, Greco S, Pesce A, Virgilio F, Bonazza L, Bagnoli L, Feo CV. Enhancing the management of acute and gangrenous cholecystitis: a systematic review supported by the TriNetX database. Translational Gastroenterology and Hepatology. 2024 Nov 29;10:16.
14. AHMAD A, FAISAL M, QADIR MR, ASLAM MU, MUHAMMAD ST. Spectrum of Histopathological Lesions in Cholecystectomy Specimens at Pak Red Crescent Teaching Hospital. (2021) 15:12.
15. Qaiser M, Rehan M, Siddique K, Anwar MI, Khan OH, Rehan K. Outcomes of patients presenting with Cholecystitis in terms of Early vs Delayed Cholecystectomy. Journal of Rawalpindi Medical College. 2021 Sep 30;25(3).
16. Khafaji MA, Bagasi JT, Albahiti SK, Alsayegh LA, Alsayyad SA, Algarni SS, Bahowarth SY, Baghdadi ES. Accuracy of ultrasound and computed tomography in diagnosing acute cholecystitis patients in a tertiary care center in Saudi Arabia. Cureus. 2023 Sep;15(9).
17. Karthikarajam V, Pushpaketu N, Badhai S, Mishra A, Sahu S, Debata I, Debata PK. Risk Factors Associated With Gangrenous Cholecystitis: A Cohort Study From Eastern India. Cureus. 2024 Nov 20;16(11).
18. Park YS, Yoon H, Kang SY, Jo IJ, Woo S, Lee G, Park JE, Kim T, Lee SU, Hwang SY, Cha WC. Use of gallbladder width measurement by computed tomography in the diagnosis of acute cholecystitis. Diagnostics. 2022 Mar 16;12(3):721.
19. Vignesh DV, James J, Patil S. A Prospective Study of Evaluation of Role of Ct in the Evaluation of Acute Cholecystitis. IOSR Journal of Dental and Medical Sciences (IOSR-JDMS). 2020;19(12):41-4.
20. Patnaik B, Jena SK, Dash P, Agrawalla DK, Jena D. Assessment of the imaging findings of Gangrenous Cholecystitis. Journal of Advanced Medical and Dental Sciences Research. 2020 Nov;8(11).