Review Article :

Gallbladder torsion: A Systematic Review of the Recent Literature

Sajad Ahmad Salati[1], Lamees Sulaiman AlSulaim[2], Saleh Alqarawi[3], Faiza Riaz Malik[4], Abdulaziz Alnuwaysir[3], Rakan alharbi[3], Turki Alwasil[3], Abdullah almethin[3], Osama Albladi[3]

1. Professor, Department of Surgery, College of Medicine, Qassim University, Saudi Arabia.
2. Assistant Professor, Department of Surgery, College of Medicine, Qassim University, Saudi Arabia.
3. Students, College of Medicine, Qassim University, Saudi Arabia.
4. Assistant Consultant, Department of Surgery, Qassim University Medical City, Saudi Arabia.

Received on Feb 18, 2024, accepted for publication on Mar 19, 2025, dx.doi.org/10.5455/mjhs.2025.04.012

Corresponding author:

Sajad Ahmad Salati , Professor, Department of Surgery, College of Medicine, Qassim University, Saudi Arabia, E-mail: docsajad@gmail.com, S.SALATI@qu.edu.sa, https://orcid.org/0000-0003-2998-7542

OPEN ACCESS Distributed under Creative Commons CC BY-NC-ND 4.0

Abstract

Gallbladder torsion is a rare surgical disorder that occurs when certain anatomical variants of the gallbladder rotate along the axis of the cystic vascular pedicle. The previous literature puts the rate of correct preoperative diagnosis at less than 10%, and delay in management has the potential to increase morbidity and mortality. In recent years, there have been significant advances in imaging techniques. Hence, a systematic analysis of 43 case reports with 44 cases published between 2020 and 2024 was undertaken to understand the current literature with respect to various variables. Only 41% of cases were diagnosed preoperatively despite the use of the latest imaging modalities, and laparoscopic cholecystectomy was the most common surgical management approach. There is a need to enhance awareness among the healthcare providers about gallbladder torsion.

Keywords:

Gallbladder torsion; gangrene; cholecystectomy; hemorrhagic necrosis; detorsion; whirl sign; bulls-eye image; systematic review

Introduction:

Gallbladder torsion (GBT) is a rare disorder that manifests as an acute surgical abdomen and has the potential to incur significant morbidity and mortality in case of delay in recognition and management[1-2]. It was described for the first time in 1898 by Wendel and since then only about 600 cases have been reported in peer reviewed English literature [3].

GBT is characterized by a mechanical organo-axial twist along the longitudinal axis of the gallbladder involving cystic artery and cystic duct. Its exact aetiology of GBT remains unknown, although certain anatomical variants are thought to predispose GB to torsion. There are five recognized congenital variations in relationship of the GB with respect to the liver as depicted in Figure 1.

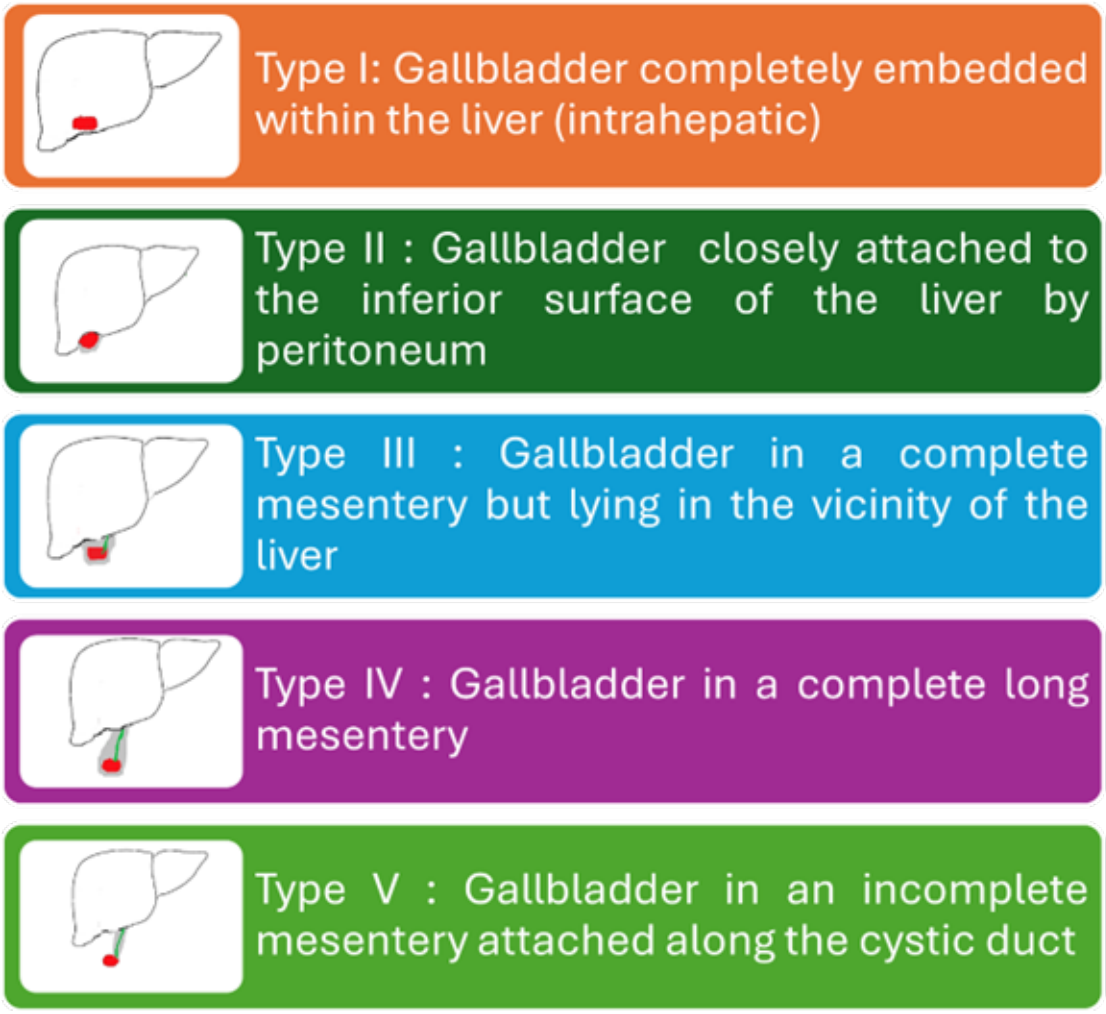


Figure 1: Congenital variations in anatomical relationship of the gallbladder (GB) with respect to the liver (Image credits: Sajad Ahmad Salati – author).

In the types 4 and 5, the GB hangs free, floating in the peritoneal cavity and has the predisposition to volvulus around the cystic pedicle in presence of inciting events like sudden changes in body position , blunt trauma , peristalsis in underlying viscera , and fatty meals leading to increased release of cholecystokinin and the resultant GB peristalsis [4-5] .Loss of visceral fat and elasticity with aging or after bariatric surgical procedures also tend to result in an elongated GB mesentery and predisposition for GBT.

GBT can be clockwise or anticlockwise and termed complete if the torsion is greater than 180 degrees and incomplete / partial if torsion is lesser than that [6]. Women in their seventh and eighth decade are more likely to be affected than the men (3-4:1), according to published case reports; however, in the pediatric age range, it is more common in boys than in girls (4:1). The diagnosis usually comes as a surprise intraoperatively, and correct preoperative diagnosis is reached in less than 10% of patients [1].

In recent times, improved investigations and imaging tools have become available which are increasingly used in emergency settings for diagnosis of patients with acute abdomen. Hence, against that backdrop, this article was compiled to review the case reports of gallbladder torsion published after 2020, and present an up-to-date summary with respect to demographics, clinical presentation, imaging, and management and thereby build on existing knowledge related to it. The ultimate objective to enhance the physician's awareness about GBT and thereby improve the ability to attain its timely diagnosis.

Materials and methods:

Methods:

A systematic review was performed according to PRISMA (preferred reporting items for systematic reviews and meta-analyses) guidelines. A literature search was performed using the PubMed, Google Scholar and PsycInfo databases, with 'gallbladder', 'torsion' and 'volvulus' as individual keywords with a combination of Boolean logic (AND). Further case reports were then compiled from the references of the initial articles.

Only the articles published in English language were considered for inclusion in this review and the time frame fixed was 2020–2024.

Criteria for considering studies:

Articles, including case series and case reports, that provided an account of the selected variables were included in the review process.

Participants and Outcome measures:

Only the articles where the diagnosis of GBT had been established on imaging or surgical exploration were included. The variables reported and analyzed include: [i] age; [ii] gender; [iii] clinical features; [iv] time between onset of symptoms and reporting to healthcare facility; [v] co-morbidities; [vi] findings on imaging; [vii] provisional diagnosis before definitive treatment ; [viii] delay between onset of symptoms and definite treatment ; [ix] treatment ; [x] operative findings; [xi] histopathology of retrieved specimen , and [xii] postoperative course.

Exclusion:

The original articles, and systematic reviews that provided no information regarding the variables were excluded. The articles in languages other than English were also excluded.

Methodological quality checking:

Checklist items from PRISMA and previously published systematic reviews were used for comparison with the checklist that was self-drafted for this study.

Data Synthesis (extraction and analysis):

Data related to the variables was derived and arranged in the form of Tables 1 & 2. The collected data was then analyzed with Statistical Package for Social Sciences (IBM-SPSS version 27.0) and Microsoft Excel (Office Version 16). The information was presented using frequencies, summary measures, tables, and figures as shown in the results.

Results:

Study selection:

As seen in Figure 2, the electronic database search yielded a total of 114 publications. Sixty-three duplicate articles were eliminated and then titles and abstracts of 51 articles were screened. The full text of 4 articles was not in the English language, leaving 47 articles that met the qualifying requirements. After further exclusion of 3 articles due to unavailability and one case series that had details of cases before 2020, the review ultimately analyzed 43 articles.

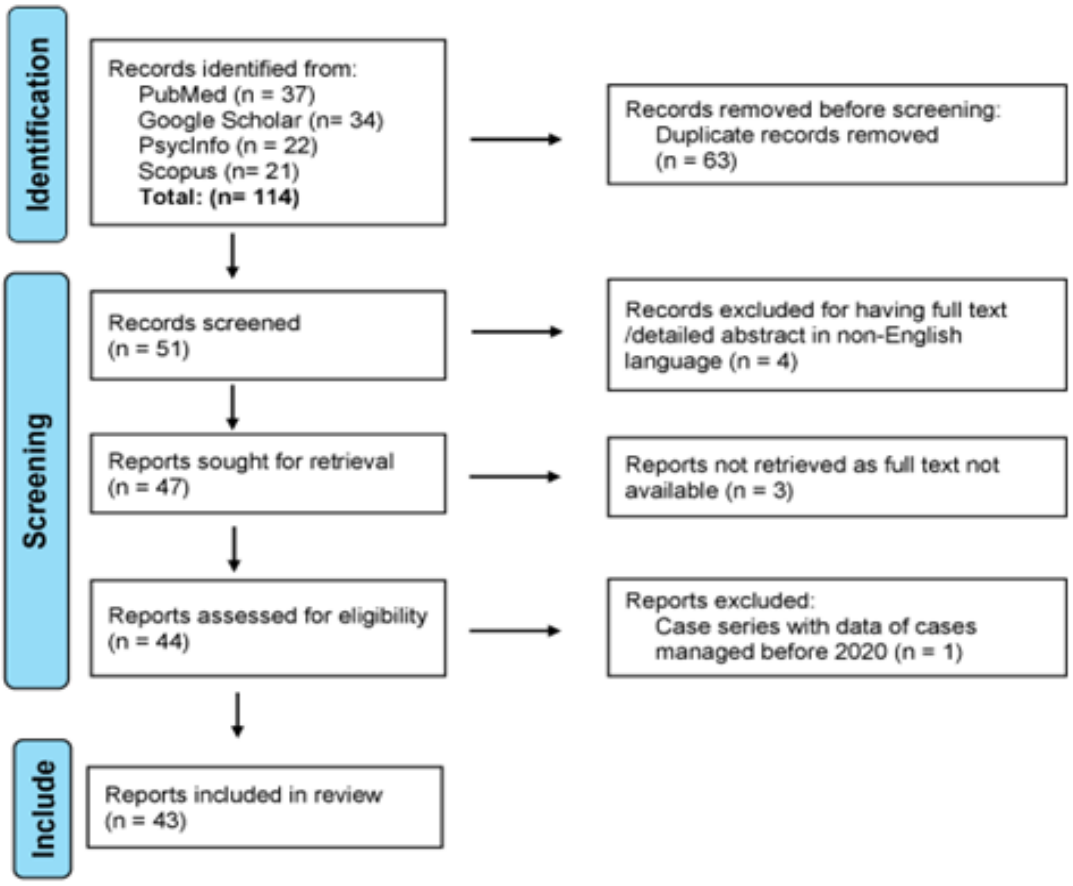


Figure 2: Flowchart of the reviewed articles.

Study characteristics: Study characteristics are presented in Tables 1 to 4

Table 1: Study characteristics of the patients of gallbladder torsion (demographics, clinical presentation, & preoperative diagnosis).

Serial	Authors / Year		Age (years)/ Gender	Clinical features (Symptoms)	Clinical features (Signs)	Co-morbidities if any	Preoperative diagnosis
1	Zillman et al.[7]	2024	94/F	AP, CP – 1 day	Tend RHC, Palpable GB, Murphy -ve	HT, CAD. GERD	AAC
2	Mittal et al.[8]	2024	79 /F	AP- 3 days	Tend , RTend RLQ	HT, Lip, AF	AAC
3	Vo et al.[9]	2024	62/M	AP– 30 days	Tend RHC, lump	None	AAC
4	Portilla-Rojas et al. [10]	2024	42/F	AP with fever – 1 day	Tend RHC	-	AA
5	Tiep et al. [11]	2024	05/F	AP & N/V – 1 day	Tend Epig.Murphys +ve	None	GBT

6	Tadesse& Sefu [12]	2024	07/M	AP, fever & N/V – 3 days	Tend Abd	None	AAC
7	Ren et al. [13]	2024	06/F	AP & N/V – 1 day	Tend RHC, lump	None	GBT
8	Nuyts et al. [14]	2024	01/F	AP ; N/V– 1 day	Tend RHC	None	GBT
9	Mohammed [15]	2024	68/F	AP, BP, fever & N/V – 2 day	Tend, guarded RHC	None	ACC
10	Keller et al. [16]	2024	68/M	AP, N/V, anorexia – 5 days	Tend Abd	None	GBT
11	Yoshida et al.[17]	2024	90/F	Anorexia -30 days; AP, BP, fever - unknown days	Tend RUQ & RLQ	HH , Cardiopulmonary disease	GBT & abscess
12	Sidhu et al. [18]	2023	80/F	AP, N/V, fatigue, anorexia – 3 days	Tend RHC	HT	AAC
13	Mohamed Ali et al [19]	2023	80/F	AP, N/V – 12 hours	Tend RHC, Murphy +ve	-	AAC, cholangitis
14	Matías-García et al. [20]	2023	87/F	AP – 2 days	Tend RHC	COPD	GBT
15	Daly et al. [21]	2023	90/F	AP, N/V -7 days	Tend RHC, palpable GB, Murphy +ve	-	ACC
16	Chugh et al. [22]	2023	90/F	AP, N/V, diarrhea anorexia – 2 days	Tend RHC, distended Abd	HT, IBS, COPD	AAC
17	Beatty et al. [23]	2023	92/F	Syncope and AF, AP- 1 day	-	HT, IHD, CKD	GBT
18	Tabbikha et al. [24]	2023	85/F	AP, N/V – 1 day	Tend RHC with lump, Murphy +ve	HT, Sjogren's synd, multiple surgeries	AAC
19	Uemura et al. [25]	2023	03/M	AP, N/V – 1 day	R-Tend RHC		GBT
20	Armistead et al. [26]	2022	88/F	AP, N/V – 1 day	Tend RHC		AAC
21	Miyata et al. [27]	2022	84/F	AP-1 day	Tend RHC with lump, Murphy +ve	-	GBT
22	Wu et al. [28]	2022	19/M	AP, N/V – 1 day	Tend RHC, Murphy +ve	-	AAC
23	Ogawa et al. [29]	2022	37/F	Pregnancy (34 weeks, G7 P3) with AP, N/V – 1 day	Non-Tend Abd		GBT
24	Keeratibharat et al.[30]	2022	27/F	AP- 2 days	Tend Epig	-	GBT
25	Muenyi et al. [31]	2022	87/F	CP , BP, N/V – 1 day	Tend RHC, Murphy +ve	HT, IHD, CCF, AF	AAC
26	Lim et al. [32]	2022	81/F	AP, N/V – 4 days	Tend LHC, palpable mass.		GBT
27	Kalyanasundaram et al. [33]	2022	87/F	AP , BP – 1 day	Tend Epig	Multiple operations	GBT

28	Uemura et al. [34]	2021	03/M	AP, N/V – 1 days	R-Tend RHC	-	GBT
29	Mejri et al. [35]	2021	90/F	AP, N/V – 1 days	Tend RHC with palpable mass	kyphosis, scoliosis.	ACC
30	Doxey et al. [36]	2021	82/F	AP, N/V -? Days	Tend RHC	HT, Lip, HH	AAC
31	Dhafer et al. [37]	2021	26/M	AP, N/V – 1 days	Tend RHC	-	GBT
32	Baig et al. [38]	2021	77/F	AP, N/V – 1 days	Tend RHC	-	AAC
33	Croce & Licata [39]	2021	81/F	AP, N/V - 1 days	Tend Abd	HT, Lip ,arthritis, hypothyroidism,	AAC
34	Chin et al.[40]	2021	92/F	AP – 3 days	Tend lump RHC, Murphy +ve	IHD, AF, CKD	GBT
35	Cecire et al. [41]	2021	84/F	AP- 2 days	Tend RHC, Murphy +ve	COPD	AAC
			81/F	AP- 1 day	Tend RHC, Murphy +ve		AAC
36	Shah et al. [42]	2021	86/F	AP, N/V –1 day	Tend distended RLQ, lump	HT, Lip, hypothyroidism, treated colon cancer	AP
37	Ahluwalia et al. [43]	2021	79/F	AP, N/V –1 day	Tend Epig, Absent BS	Multiple previous surgeries in the past; HT, AF, RBBB	ACC
38	Sai Krishna et al. [44]	2021	75/F	AP, N/V –2 day	Tend umbilical area		ACC
39	Bouzas Cardaci et al. [45]	2020	88/F	AP- 1 day	Tend RUQ	HT, Lip	AAC
40	Hong Duc et al. [46]	2020	26/F	AP- 1 day	Tend RIF		AAC
41	Bergeron et al. [47]	2020	84/F	AP, BP - 1 day	Tend Abd,Murphy -ve		GBT
42	Chai et al. [48]	2020	82/F	AP, N/V, fever –6 days	Tend infraumbilical mass	HT, PE , hysterectomy	GBT
43	Najmadini et al. [49]	2020	85/M	AP, N/V –2 days	Tend, R-Tend Abd		AAC

AP- Abdomen pain; BP- Back pain ;CP-Chest pain; N/V- Nausea & vomiting ; Tend- Tender ; R-Tend- Rebound tender ; Abd -Abdomen ; BS- Bowel sounds; GB -Gallbladder; AAC- Acute acalculous cholecystitis ; ACC - Acute calculous cholecystitis ; AC - Acute cholecystitis ; AG - Acute gastritis; AP - appendicitis ; AA- acute abdomen ; HT - Hypertension ; COPD- chronic obstructive pulmonary disease ; IBS - Irritable bowel syndrome ; IHD - Ischaemic heart disease ; CKD - Chronic kidney disease ; AF- Atrial fibrillation; RBBB- right bundle branch block; RIF- right iliac fossa; RHC - right hypochondrium ; LHC - left hypochondrium ;RLQ-: right lower quadrant ; RUQ - right upper quadrant; Epig -epigastrium ; THR - total hip replacement; AF- Atrial fibrillation; Lip - hyperlipidemia; HH-hiatal hernia

Table 2: Study characteristics of the patients of gallbladder torsion (imaging studies).

Serial	Authors	USG Abdomen	CT scan Abdomen	Others imaging studies
1	Zillman et al.[7]	Dis-GB, Thi-GB, with sludge, Dilated CBD	Dis-GB, Thi-GB, with no GS, CBD 9mm	
2	Mittal et al.[8]	Dis-GB, with sludge	Dis-GB, Thi-GB, with no GS; dilated CBD	**MRCP**: Dis-GB, Thi-GB, CBD -11 mm, tapering normally.
3	Vo et al.[9]	Dis-GB, Thi-GB, no GS	Dis-GB, Thi-GB, no GS; FF	-
4	Portilla-Rojas et al. [10]	-	-	-
5	Tiep et al. [11]	Dis-GB, Thi-GB, with sludge; no Doppler flow, GB deviated to left, cone-shaped hypoechogenic area	GB: Dis-GB with decreased contrast uptake, hyperdense nodule at the neck.	-
6	Tadesse & Sefu [12]	Thi-GB, no GS, free fluid	-	**Xray** abdomen: Normal
7	Ren et al. [13]	Two cystic areas, i) at RHC, ii) at the GB fossa.	An oval low-density shadow at the lower edge of the liver.	**MRI + MRCP**: No GB but a tortuous tubular hyperintense structure in GB fossa.
8	Nuyts et al. [14]	Dis-GB, Thi-GB, with horizontal lie, no colour Doppler flow, not lying in fossa; no GS	-	-
9	Mohammed [15]	Thi-GB with single 16 mm calculus	-	-
10	Keller et al. [16]	Dis-GB, Thi-GB, with sludge	Dis-GB directed towards LHC, nodular enhancement along the right margin of the GB	**HIDA**: adequate uptake & GB not visualized. **MRCP**: GB edematous with T1W hyperintense signal within the wall & transverse orientation
11	Yoshida et al.[17]	-	GB not visualized; torsion of GB neck and continuous with 10 cm fluid collection, reaching anterior abdominal wall.	-
12	Sidhu et al. [18]	-	Dis-GB, Thi-GB, no GS, an ill-defined density within the CDt, & GB fundus shifted to pelvis.	-
13	Mohamed Ali et al [19]	Dis-GB, Thi-GB, no GS	Dis-GB, Thi-GB, no GS, CBD 10 mm.	-
14	Matías-García et al. [20]	Dis-GB, Thi-GB, lying outside fossa, no GS	Dis-GB outside GB fossa, a twist on its vascular pedicle.	-

15	Daly et al. [21]	Dis-GB, Thi-GB, with sludge		-
16	Chugh et al. [22]	Dis-GB, with sludge	Dis-GB, Thi-GB, lying in pelvis	-
17	Beatty et al. [23]	-	Dis-GB, Thi-GB, inferior to right lobe of liver	-
18	Tabbikha et al. [24]	Dis-GB, Thi-GB, no GS	Dis-GB, Thi-GB, no GS, FF	-
19	Uemura et al. [25]	Dis-GB, no GS Repeat USG: Thi-GB (12 mm) without intramural blood flow	Dis-GB, ascites.	-
20	Armistead et al. [26]	-	Dis-GB, Thi-GB, no GS, 12 mm CBD, HH, FF	-
21	Miyata et al. [27]	-	Dis-GB, Thi-GB with single gallstone in the GB neck	MRCP: "swirl" sign +ve,. GB - extremely low intensity.
22	Wu et al. [28]	Dis-GB, Thi-GB, no GS	Dis-GB, Thi-GB, no GS, beak like tapering of structure between the GB and the CD.	-
23	Ogawa et al. [29]	Dis-GB, Thi-GB, no GS	Dis-GB, Thi-GB lying outside the hepatic bed	-
24	Keeratibharat et al.[30]	Dis-GB, no GS	Dis-GB, Thi-GB in the hepato-gastric recess, reduced doppler flow	-
25	Muenyi et al. [31]	Dis-GB, Thi-GB, no GS; CBD-10mm	Dis-GB, Thi-GB , FF	-
26	Lim et al. [32]	Thi-GB in LUQ, GS present, probe tenderness +ve	Dis-GB, Thi-GB, lying to the left of midline, fat-stranding, Swirl sign +ve	-
27	Kalyanasundaram et al. [33]	-	Dis-GB to the left of midline, anterior to the gastric pylorus, with wall ischemia & no GS	-
28	Uemura et al. [34]	Dis-GB, Thi-GB, GB displaced into pelvis; no GS; repeat USG (at 1 day) - lack of mural blood flow	Swollen GB with ascites.	-
29	Mejri et al. [35]	Dis-GB, Thi-GB, displaced into RIF; no GS.	-	-
30	Doxey et al. [36]	Dis-GB, Thi-GB, no GS	HH, Dis-GB with sludge, FF , Dilated bile ducts.	HIDA - delayed visualization of GB
31	Dhafer et al. [37]	Thi-GB, no GS	Thi-GB, abrupt tapering of the CD & CA.	

32	Baig et al. [38]	Dis-GB, Thi-GB, no GS, sonographic Murphy +ve	Distended and non-enhancing GB	HIDA scan: normal uptake and flow; GB not visualised. MRCP: Dis-GB, Thi-GB FF, no GS.
33	Croce & Licata [39]	Dis-GB, Thi-GB, no GS, dilated CBD	Distended GB with thickened wall	-
34	Chin et al.[40]	Dis-GB, Thi-GB, no GS; sonographic Murphy +ve	Dis-GB, Thi-GB with an abrupt cut-off of the cystic duct; widespread FF	-
35	Cecire et al. [41]	Dis-GB, Thi-GB, no GS.	Dis-GB, Thi-GB extending to RIF	-
		Dis-GB, Thi-GB, no GS; FF; probe tenderness		-
36	Shah et al. [42]		Cystic structure abutting the right anterior abdomen	-
37	Ahluwalia et al. [43]	Dis-GB, Thi-GB, no GS; free fluid around the liver.	Dis-GB, Thi-GB, no GS; fat stranding	-
38	Sai Krishna et al. [44]	Dis-GB, Thi-GB; FF, gall stones present; colour Doppler - no intramural blood flow in GB	Over-distended GB with thickened wall	-
39	Bouzas Cardaci et al. [45]	Dis-GB, Thi-GB, no GS	Dis-GB, Thi-GB, no GS	MRCP: distended GB with wall thickening, and FF
40	Hong Duc et al. [46]	Dis-GB, Thi-GB, no GS; free fluid around the liver.	Dis-GB, Thi-GB, no GS; FF	
41	Bergeron et al. [47]	Dis-GB, Thi-GB, no GS; free fluid around the liver.	Dilatation of the GB up to 5 × 5 × 9:5 cm, and fatty infiltration	HIDA: Adequate uptake /flow & visualization of GB activity within 4 minutes; SPECT-CT: discrepancy in GB size.
42	Chai et al. [48]	Dis-GB, Thi-GB with GS; multiple cysts in the liver and kidney	Thi-GB; ectopic GB with gall stones; multiple cysts in the liver and kidneys	MRI: an ectopic Dis-GB, Thi-GB with GS. MRCP: a V-shaped extrahepatic bile ducts, twisted CD
43	Najmadini et al. [49]	Dis-GB, Thi-GB, free fluid around liver and GB.	-	-

GB -Gallbladder; Dis-GB – Distended gallbladder; Thi-GB – Thick-walled gallbladder; CBD- Common bile duct; CD- cystic duct; USG- Ultrasonography; CT- Computed tomography; HIDA-Hepatic iminodiacetic acid scintigraphy; MRCP - Magnetic resonance cholangiopancreatography; SPECT-CT – Single photon emission computed tomography; RIF- right iliac fossa; RHC - right hypochondrium; LHC - left hypochondrium; GS-Gallstones

Table 3: Study characteristics of the patients of gallbladder torsion (management).

Serial	Authors	Time from onset to operation (days)	Operation approach	Operative findings	Direction of GB rotation	Operative steps
1	Zillman et al.[7]	1	Lap	Gangrenous GB rotated along a loose connection of GB to its fossa.	Counter	DGB & chole
2	Mittal et al.[8]	3	Lap	Distended, gangrenous free lying GB twisted 180 degrees on CP	Clo	DGB & chole
3	Vo et al.[9]	33	Lap	Minimal FF; Distended, edematous GB twisted on a long mesentery by 180 degrees	Counter	DGB & chole
4	Portilla-Rojas et al. [10]	1	Lap	Distended, gangrenous GB twisted on a CP.	-	DGB & chole
5	Tiep et al. [11]	N/A	Lap	Distended, gangrenous GB twisted 270 degrees at neck.	Clo	DGB & chole
6	Tadesse& Sefu [12]	3	Op	Bilious peritoneal fluid, gangrenous GB twisted 360-degrees on long CP and perforated at its fundus.	Counter	DGB & chole
7	Ren et al. [13]	2	Lap	Congested GB adherent to omentum and twisted 720-degrees at CP.	Counter	DGB & chole
8	Nuyts et al. [14]	1	Lap	GB free, thick-walled and gangrenous, rotated 720 degrees.	Counter	Percut.GB & chole
9	Mohammed [15]	5	Lap	GB adhered to omentum, thick-walled, gangrenous, rotated at neck.	Counter	DGB & chole
10	Keller et al. [16]	N/A	Op	Gangrenous GB with fundus lying to the left of umbilicus, twisted at CP	-	DGB & chole
11	Yoshida et al.[17]	N/A	Percut	-		USG-guided drainage, AB
12	Sidhu et al. [18]	4	Lap	Complete volvulus of a distended, gangrenous GB around CP	Clo	DGB & chole
13	Mohamed Ali et al [19]	N/A	Op	Distended gangrenous GB with 360 degrees torsion around CP.	Counter	DGB & chole
14	Matías-García et al. [20]	2	Con	Distended gangrenous GB with 720 degrees torsion.	Counter	DGB & chole
15	Daly et al. [21]	8	Lap	Distended gangrenous GB with 360 degrees torsion around an elongated and narrowed mesentery.	Clo	DGB & chole

16	Chugh et al. [22]	N/A	Lap (robotic)	Gangrenous, freely suspending, GB adhered to duodenum and colon. Torsion on CP	N/A	DGB & chole
17	Beatty et al. [23]	NA	Lap	Gangrenous, distended GB with 360 degrees torsion on long CP	Clo	DGB & chole
18	Tabbikha et al. [24]	N/A	Op	Twisted, distended, necrotic, GB. Mild bloody ascites.	N/A	DGB & chole
19	Uemura et al. [25]	2	Lap	Gangrenous, distended GB with 270 degrees torsion on long CP; bloody ascites	Counter	DGB & chole
20	Armistead et al. [26]	2	Lap	Twisted, distended, gangrenous GB.	Counter	DGB & chole
21	Miyata et al. [27]	2	Lap	Necrotic, distended, floating GB rotated 180° at its neck	Clo	DGB & chole
22	Wu et al. [28]	2	Lap	Gangrenous, distended GB with 180 degrees torsion on a thin mesentery	Counter	DGB & chole
23	Ogawa et al. [29]	2	Op	GB distended, gangrenous, and floating from the liver, with a 360 degrees torsion around CP	Clo	DGB & chole; CS
24	Keeratibharat et al.[30]	3	Lap	Distended, gangrenous GB rotated 360 degrees around CP, displaced to gastro-hepatic recess	Counter	DGB & chole
25	Muenyi et al. [31]	2	Lap	Distended, gangrenous, floating GB twisted 360 degrees around CP	Counter	DGB & chole
26	Lim et al. [32]	5	Lap	Distended, gangrenous GB twisted 270 degrees torsion around CP; dense adhesions.	Clo	DGB & chole
27	Kalyanasundaram et al. [33]	1	Lap	Distended, gangrenous GB shifted towards left.	N/A	chole
28	Uemura et al. [34]	3	Lap	Distended, gangrenous GB with adhesions, twisted 270 degrees around CP; bloody ascites.	Counter	DGB & chole
29	Mejri et al. [35]	1	Op	Distended GB descended into RIF and twisted 720 degrees around a thin mesentery.	Counter	DGB & chole
30	Doxey et al. [36]	5	Lap	Distended necrotic GB twisted 360 degrees around long CP; dense adhesions.	Counter	DGB & chole
31	Dhafer et al. [37]	1	Lap	GB gangrenous, hanging freely twisted 180 degrees around CP	N/A	DGB & chole

32	Baig et al. [38]	5	Con	Gangrenous GB, hanging freely, twisted 180 degrees around CP	Counter	DGB & chole
33	Croce & Licata [39]	2	Con	GB floating, twisted 360 degrees around CP; bloody ascites; inflamed peritoneum.	Clo	DGB & chole
34	Chin et al.[40]	1	Lap	Distended, gangrenous GB twisted on the hepatocystic ligament.	N/A	DGB & chole
35	Cecire et al. [41]	10	Lap	GB twisted on CP	N/A	DGB & chole
		1	Lap	Dark and congested GB without evidence of perforation and twisted around CP	N/A	DGB & chole
36	Shah et al. [42]	2	Lap	Gangrenous GB	N/A	DGB & chole
37	Ahluwalia et al. [43]	3	Lap	Extensive adhesions: distended, dusky, necrotic free-floating GB twisted 360 degrees on CP.	Counter	DGB & chole
38	Sai Krishna et al. [44]	2	Op	Purulent fluid collection in the RUQ; Gangrenous, congested. GB twisted 180 degrees over a loose mesentery.	Clo	DGB & chole
39	Bouzas Cardaci et al. [45]	3	Lap	Distended, necrotic, dark GB twisted 180 degrees.	Counter	DGB & chole
40	Hong Duc et al. [46]	3	Lap	Distended, gangrenous GB with a long mesenteric attachment & twisted 360 degrees around CP	Clo	DGB & chole
41	Bergeron et al. [47]	3	Lap	Distended GB, twisted 2 cm proximal to CD with a sharp demarcation between gangrenous and healthy GB	N/A	Partial chole with stapler
42	Chai et al. [48]	N/A	Lap	Swollen, descended, necrotic GB adhered to abdominal wall with 360 degrees twist.	Counter	Chole
43	Najmadini et al. [49]	2	Op	Gangrenous GB with torsion	N/A	DGB & chole

GB – Gallbladder; CBD- Common bile duct; CD- Cystic duct FF – Free fluid ; CP -Cystic pedicle ; Percut – Percutaneous decompression ; Chole – Cholecystectomy; USG- Ultrasound; AB- Antibiotics; CS- Cesarean section; RIF - Right iliac fossa ; RUQ- Right upper quadrant; Lap- Laparoscopic; Op- Open ; Clo- Clockwise ; Counter- Counterclockwise ; DGB- Detorsion of gallbladder ; Con - Conversion of laparoscopic to open approach; N/A - Not available or applicable.

Table 4: Study characteristics of the patients of gallbladder torsion (histopathology and postoperative course).

Serial	Authors	Histopathology	Postoperative hospital stay (days)	Complications, if any.
1	Zillman et al.[7]	Necrotizing cholecystitis with interstitial hemorrhage; no gallstones	N/A	None
2	Mittal et al.[8]	Acute necrotizing cholecystitis with intraluminal blood clot	1	None
3	Vo et al.[9]	Acute cholecystitis, no features of malignancy.	2	None
4	Portilla-Rojas et al. [10]	Acute necrotizing cholecystitis	2	None
5	Tiep et al. [11]	GB wall necrosis, interstitial hemorrhage and fibrin necrosis. No calculi.	7	None
6	Tadesse& Sefu [12]	N/A	4	None
7	Ren et al. [13]	Thickened GB wall with fibrosis & hyalinization.	N/A	None
8	Nuyts et al. [14]	Gangrenous cholecystitis with no evidence of calculi	4	None
9	Mohammed [15]	N/A	3	None
10	Keller et al. [16]	N/A	N/A	None
11	Yoshida et al.[17]	N/A	N/A	None
12	Sidhu et al. [18]	Haemorrhagic gangrene, engorged veins, no calculi	N/A	None
13	Mohamed Ali et al [19]	N/A	5	None
14	Matías-García et al. [20]	Transmural hemorrhagic necrosis of GB; no calculi	6	None
15	Daly et al. [21]	Transmural ischaemic necrosis of GB with suppuration & hemorrhage	8	None
16	Chugh et al. [22]	N/A	5	HAD
17	Beatty et al. [23]	Diffuse haemorrhagic necrosis of the GB, no dysplasia or neoplasia, no calculi.	N/A	Stroke
18	Tabbikha et al. [24]	GB with hemorrhagic necrosis, no neoplasia.	3	None
19	Uemura et al. [25]	Gangrenous cholecystitis with no calculi	6	None
20	Armistead et al. [26]	GB with hemorrhagic necrosis	2	None
21	Miyata et al. [27]	GB with transmural hemorrhage and necrosis	5	None
22	Wu et al. [28]	Full-thickness hemorrhage and necrosis of the GB wall	2	None
23	Ogawa et al. [29]	Haemorrhagic infarction of GB without any calculi	6	None
24	Keeratibharat et al.[30]	Gangrenous cholecystitis, no calculi.	N/A	None

25	Muenyi et al. [31]	Necrotizing cholecystitis, no dysplasia nor neoplasia.	3	None
26	Lim et al. [32]	Transmural ischemic necrosis, vascular congestion, submucosal hemorrhage.	2	None
27	Kalyanasundaram et al. [33]	Pre-existing chronic cholecystitis with recent venous infarction.	N/A	None
28	Uemura et al. [34]	Gangrenous cholecystitis without gallstones	6	None
29	Mejri et al. [35]	Acute ischemic cholecystitis, no neoplasia	3	None
30	Doxey et al. [36]	Chronic cholecystitis with transmural necrosis.no calculi.	N/A	None
31	Dhafer et al. [37]	N/A	N/A	None
32	Baig et al. [38]	Gangrenous cholecystitis with hemorrhage.	2	None
33	Croce & Licata [39]	N/A	N/A	None
34	Chin et al.[40]	Acute suppurative, necrotising, haemorrhagic cholecystitis.	N/A	None
35	Cecire et al. [41]	N/A	4	None
		Acute-on-chronic cholecystitis with necrotic areas.	3	None
36	Shah et al. [42]	Acute hemorrhagic necrosis of the GB, no calculi.	2	None
37	Ahluwalia et al. [43]	Haemorrhagic infarction of the GB with inflammation,	4	None
38	Sai Krishna et al. [44]	N/A	4	None
39	Bouzas Cardaci et al. [45]	Acute cholecystitis with hemorrhagic mural necrosis.	3	None
40	Hong Duc et al. [46]	Transmural GB necrosis, no calculi.	5	None
41	Bergeron et al. [47]	Acute necrotic cholecystitis with no calculi.	-	None
42	Chai et al. [48]	Acute gangrenous cholecystitis.	5	None
43	Najmadini et al. [49]	N/A	4	None

GB – Gallbladder; N/A- Not available or applicable; HAD - Hospital induced delirium

There were 43 included case reports with 44 cases (n = 36, 83.3% females, and n = 8, 16.7% males), ranging in age from 01 to 94 years (mean 65 ± 31.3 years). There were 38 adults (33 females, 5 males) and 6 (3 females, 3 males) children, and hence, the ratio of females to males was 6.6:1 and 1:1 in the adults and children, respectively. As depicted in Figure 3, there was an early peak comprising 6 (13.6%) pediatric cases aged below 10 years, and there were 32 (72.7%) cases aged above 60 years.

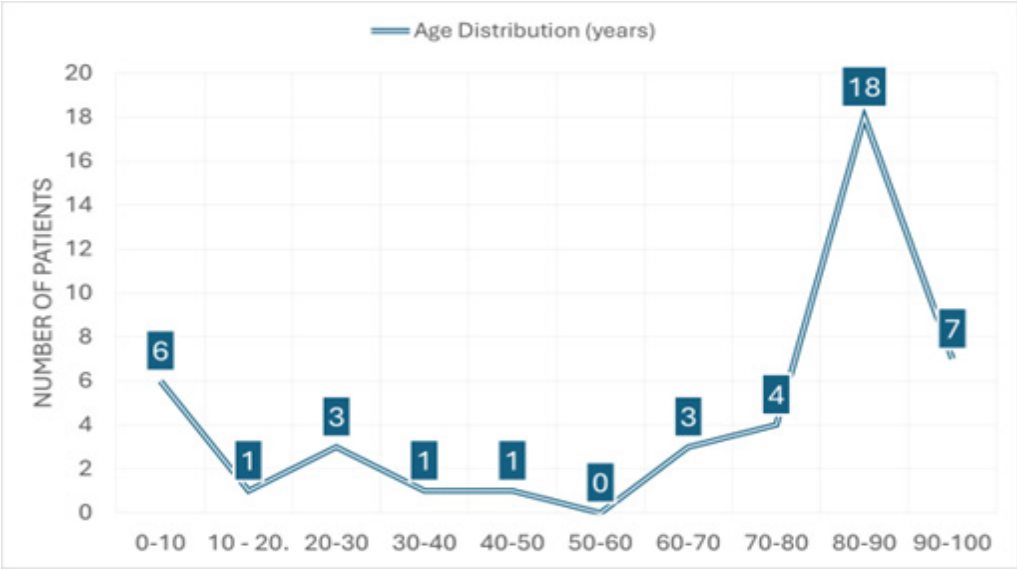


Figure 3: Age distribution of the patients of gallbladder torsion.

Abdominal pain was the most prominent symptom in 43 (97.7%) cases, and one (2.3%) patient had chest pain. Nausea and vomiting was experienced by 21 (47.7%) cases. Abdominal tenderness of various degrees was found in all (100%) cases. Murphy's sign of cholecystitis was positive in 10 (22.7%) cases, and an abdominal lump was palpable in 9 (20.4%) cases. There were significant comorbidities (hypertension, ischemic heart disease, chronic obstructive pulmonary disease, hiatus hernia) or a history of previous abdominal operations in 18 (40.9%) cases. One patient was pregnant (34 weeks).

Time from onset of symptoms to presentation at the healthcare facility was unknown in 2 cases. The majority (n=36; 81.8%) presented within 72 hours, and 25 (56.8%) cases presented within 24 hours, as depicted in Figure 4.

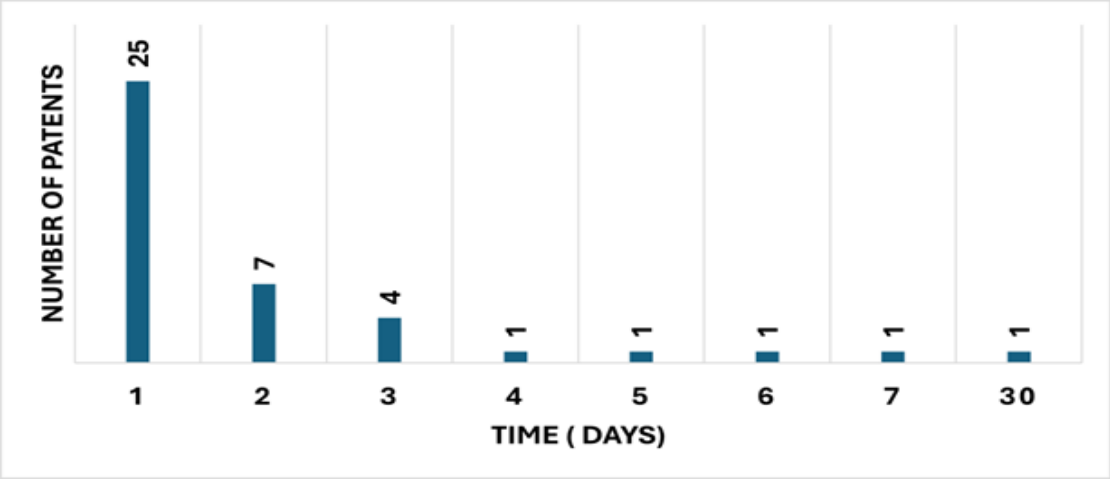


Figure 4: Time elapsed between the onset of symptoms and reporting to the healthcare facility.

Ultrasound of the abdomen was the imaging modality performed in 37 (84.1%) cases, and in 30 (68. %), USG was followed with a CT scan. In 6 (13.6%) cases, CT was undertaken as the first imaging modality without USG. Furthermore, MRCP (n = 6.8%), MRI with MRCP (n = 2; 4.5%), HIDA (n = 2; 4.5%), HIDA with MRCP (n = 2; 4.5%), and X-ray abdomen (n = 1; 2.3%) were other imaging tools used for diagnosis. In 1 (2.3%), no imaging was undertaken due to non-availability. After clinical assessment and imaging, a provisional diagnosis of GBT was made in only 18 (40.1%) as depicted in Figure 5, and 26 (59.9%) were misdiagnosed as AAC (n=43.2%), ACC (n=4; 11.4%), non-specific acute abdomen (n=1; 2.3%), and appendicitis (n=1; 2.3%).

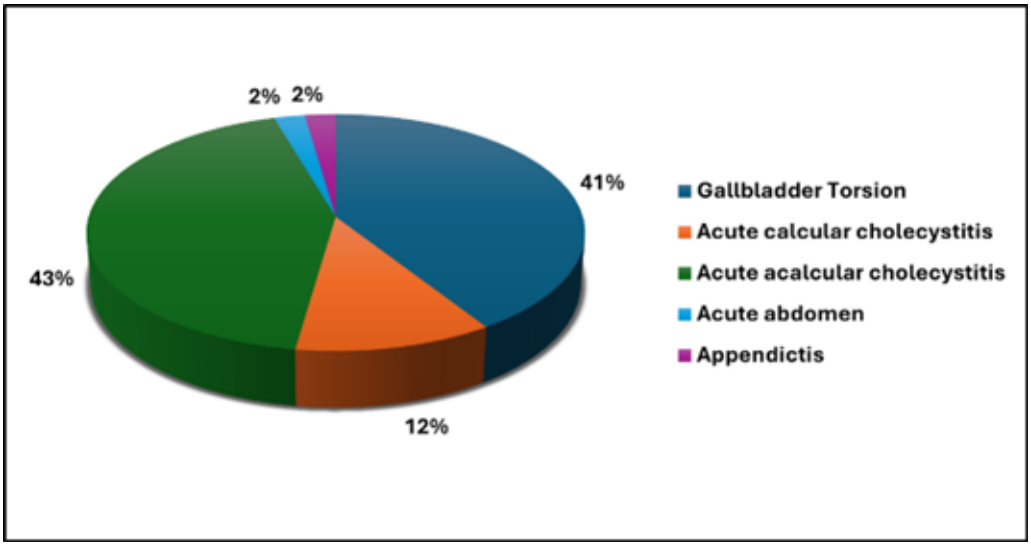


Figure 5: Preoperative diagnosis of the patients.

Time delay from onset of symptoms till definitive management was not clearly mentioned in 8 (18.2%), and in the remaining 36 cases, the mean delay was 84 hours. Twenty (45.4%) cases were managed within 48 hours, 13 (29.5%) cases between 2-5 days, and only 3 (6.8%) cases beyond 5 days. The treatment was surgical in 43 (97.7%) and non-surgical in 1 (2.3%). The approach to surgical treatment was laparoscopic in 32 (72.7%), including one robot-assisted, and open/laparotomy in 11 (25%). The operations involved detorsion of GB followed with cholecystectomy (n= 39, 90.7%), percutaneous decompression of GB followed with cholecystectomy (n= 1, 2.3%), cholecystectomy (n= 2, 4.7%), and partial cholecystectomy with staplers (n= 1, 2.3%). In the lone pregnant patient, a caesarean section was conducted along with detorsion of GB and cholecystectomy. The non-surgical management adopted in one

patient was imaging-guided percutaneous drainage of an abscess and antibiotics.

In 37 (84.1%) cases, features of gangrene were visible on surgical exploration. These changes were confirmed on histopathological analysis of the retrieved specimen, which revealed features of ischemic necrosis with accompanying hemorrhage and inflammation. In none of the specimens was there any evidence of dysplasia or malignancy. The direction of torsion was mentioned in 31 (70.5%) cases, and it was counterclockwise in 20 (45.4%) and clockwise in 11 (25%). The magnitude of torsion was mentioned in 27 (61.3%) cases, and it ranged from 180 to 720 degrees, being 180 in 8 (18.2%), 270 in 4 (9.1%), 360 in 12 (27.7%), and 720 degrees in 3 (6.8%) cases.

The postoperative phase was uneventful without any significant complications in 41 (93.2%) cases. One patient suffered from hospital-induced delirium, and in another, there was a stroke (left parietal infarct), leading to an extended in-hospital stay.

Discussion:

Only 44 documented cases of GBT from 2020–24 were found in the current study, confirming the disorder's rarity. In adults, the female to male ratio was 6.6:1, while in children, it was 1:1. This contrasts with other findings in the literature, which show that the female to male ratio is 3–4:1 for adults and 1: 4 for children [1]. As shown in Figure 2, 32 (72.7%) of the cases were over 60, 25 (56.7%) were in their ninth or tenth decade of life, and 18 (40.9%) had substantial comorbidities or a history of prior abdominal surgeries. This agrees with the literature that links this disorder to advancing age and significant comorbidities, therefore it's critical to get the right diagnosis as soon as possible. In the systematic review of 324 patients of GBT by Reilly et al. [1], the median age was 77 years.

Abdominal pain with abdominal tenderness (with or without rebound tenderness) were clinical features in 43 cases (97.7%) cases whereas nausea and vomiting was experienced by 21 (47.7%) cases. Murphy's sign of cholecystitis was positive in 10 (22.7%) cases and an abdominal lump was palpable in 9 (20.4%) cases. A clear clinical pattern that can be characterized as three triads (triad of triads), as shown in Figure 6, emerged when Lau et al. reviewed the clinical features of GBT reported in the literature. They reaffirmed that if the majority, but not necessarily all, of these features in three triads are present, a clinical suspicion or diagnosis of GBT should be raised.

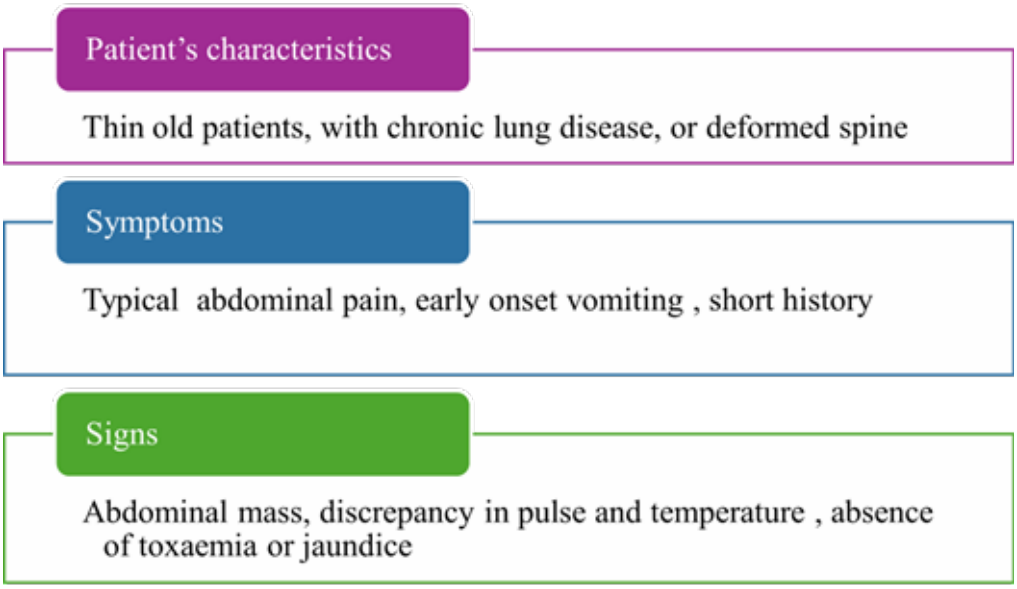


Figure 6: Lau's 'triad of triads' for clinical features related to gallbladder torsion.

In the current review, an 87-year- old female patient reported by Muenyi et al. [29] had chest pain as the presentation of GBT and a 94-year-old male patient reported by Zillman et al. [5] had chest pain in addition to abdomen pain. These cases demonstrate that GBT can present with sudden onset of chest pain, and hence GBT must be borne in mind as a differential diagnosis as was suggested by Ferguson and Bhalerao[51] when they reported an 88-year-old female patient who had presented with severe central chest pain and in whom, the diagnosis was made intraoperatively on laparotomy.

Most cases (n=36; 81.8%) reported to the healthcare facility within 72 hours of the onset of symptoms, and 25 (56.8%) cases presented within 24 hours, as depicted in Figure 3. Time delay (mean) from the onset of symptoms till definitive management mentioned in 36 (81.8%) was 84 hours. This delay can be attributed to the fact that despite clinical assessment and imaging, GBT was not suspected, and a correct diagnosis was made in only 18 (40.1%) as depicted in Figure 4, leading erroneously to the adoption of a conservative line of action. This figure concurs with the data in the previous literature [1]. Reilly et al. [1] in 2012 conducted an extensive review of a total of the case reports of GBT published between 1991 and 2011. They found that a correct preoperative diagnosis was made in only 32 of 125 (26%) patients. Nakao et al.[52] in 1999 reviewed 245 cases reported in the Japanese literature and found that only 9.8% of all GBT cases (pediatric and adult) could be diagnosed preoperatively.

During evaluation, imaging was undertaken in 43 cases (97.7%), and only in 1

(2.3%) patient, surgical exploration was undertaken without any imaging due to its non-availability. Ultrasound of the abdomen was the primary imaging undertaken in 37 (84.1%) cases, whereas in 6 (13.6%) cases, CT was undertaken as the first imaging. In 30 (68. %), USG was followed with a CT scan of the abdomen. In 6 (13.6%) cases, MRCP and HIDA were undertaken either alone or in combination. Distended GB with thickened wall was the common finding in USG, and cholelithiasis was detected in only 5 (11.36%) cases. This is in contrast with the review by Reilly et al. [1], where cholelithiasis was found in 32% of cases, though calculi are deemed as incidental findings and not believed to play any significant role in the etiopathogenesis of GBT of the condition [52].

In the current review, USG findings were able to guide towards the correct diagnosis in only 5 (33.3%) cases where GBT was established preoperatively and USG had been conducted, pointing towards the low sensitivity of the modality. The suspicious findings included deviation of the GB fundus away from the GB bed and lack of vascular flow. Tiep et al. [9] could pick up a cone-shaped hypoechogenic structure with probe tenderness. In a case presented by Uemura et al. [23], USG and CT scan misdiagnosed a 3-year-old boy as AAC, and when USG was repeated at 48 hours due to clinical deterioration while on conservative treatment (antibiotics, intravenous fluids), GST was diagnosed due to the thickened GB wall and lack of mural blood flow. Dasyam et al. [53] have described a "knot"-like hyperechoic nodular appearance of the twisted cystic duct close to the GB neck in GBT and named it the 'cystic duct knot sign' in ultrasound and suggested that the presence of this sign should prompt the diagnosis of GBT, but this sign was not apparent in any case in the current review.

Like USG, the CT abdomen scan also lacked sensitivity and guided towards the correct diagnosis of GBT in only 7 out of 36 cases (19.4%) where CT had been conducted. The common findings detected by CT included GB dilatation, wall edema, shift of GB fundus away from GB bed, and pericholecystic/intraperitoneal fluid. The actual twist/swirl around the GB neck/cystic pedicle was documented in 3 (8.3%), whereas diminished enhancement of GB and abrupt cut-off/tapering were detected in 2 (5.5%) cases each. These findings concur with the literature [1], though multidetector CT (MDCT) has been reported to be successful in the preoperative diagnosis of GBT [54-55]. MDCT can reveal a V-shaped distortion of the extrahepatic biliary ducts and a twisted pedicle

inferior to the liver in pre-contrast studies and poor enhancement of the GB wall and "beak" and 'whirl' or 'swirl' sign [31]. The "whirl sign" describes the appearance of the twisted cystic pedicle and is best delineated when the visualization plane is perpendicular to the axis of the cystic pedicle[56]. This sign was documented by Miyata et al. [27] in an MRCP study of an 84-year-old female, leading to a preoperative diagnosis of GBT.

In the current series, an 87-year-old female patient reported by Kalyanasundaram et al. [31] in 2021 had a GB-like suspicious structure to the left of the midline anterior to the gastric pylorus with significant inflammatory changes and features of ischemia, suggestive of GBT. However, in her previous CT scan recorded three years prior in 2018, GB was in the correct anatomical location, lending support to the theory that reduction of visceral fat and elasticity with aging tends to elongate the GB mesentery, thereby predisposing to GBT. MRI abdomen/MRCP and/or HIDA scans were used as supplementary imaging tools in 9 (20.4%) and were effective (100% sensitivity and specificity) in the identification of GBT, displaying features such as an ectopic enlarged GB with transverse lie, tapered cystic duct with a swirl sign, and V-shaped distortion of the extrahepatic bile ducts. These features are consistent with the description given in the literature[57]. GBT has been reported to manifest as a 'bulls-eye' image on hydroxyiminodiacetic acid (HIDA) scans because of the accumulation of the radioisotope within the GB [58], but such an image was not reported in the cases enrolled in this review.

Lack of awareness about GBT and hence the failure to consider it as a differential diagnosis in acute abdomen leads to delays in management despite the availability and utilization of advanced imaging tools. A case included in the current review and reported by Bergeron et al. [47] is a perfect example of this situation. Their patient was an 84-year-old female (BMI = 17.3) who had reported with back pain. X-ray revealed osteoporosis with two vertebral fractures. She was discharged home with analgesics only to be admitted the following day with clinical deterioration. Abdominal USG showed distended GB with wall thickening, but no calculi. After a further delay of one day, the possible diagnosis of acute cholecystitis prompted 99mTc-labeled hepatobiliary iminodiacetic (HIDA) scintigraphy, as well as a dynamic scintigraphy of 20 minutes with a single photon emission computed tomography (SPECT-CT). Adequate he-

patic uptake of radionuclide was observed, followed by a rapid biliary tree excretion and visualization of gallbladder activity within 4 minutes, raising the possibility of a pathologic process other than acute cholecystitis. Following an additional day's delay, an abdominal CT scan was requested, which revealed dilatation of the gallbladder up to5×5× 9.5 cm, fatty infiltration surrounding the GB, and a small amount of free fluid. The dimension of GB on CT scan correlated with that on USG (9 cm) but not with the HIDA scan (3 cm). After reviewing the imaging thoroughly, the discrepancy in the dimensions of the GB between the imaging tools was explained by a "missing" part of the GB on the HIDA scintigraphy, and a possibility of GBT was entertained, leading to laparoscopy where the diagnosis got confirmed. The case presented by Hong Duc et al. [46] was initially misdiagnosed as acute appendicitis, Fitz-Hugh-Curtis syndrome, and acute cholecystitis despite imaging including multiple USG scans and CT scans, and it was on laparoscopy after 3 days that GBT got detected. These cases also serve as a reminder that laparoscopy should continue to be utilized as a tool for diagnosis and therapeutics in challenging cases.

GBT is unlikely to respond to conservative treatment or percutaneous cholecystostomy, and hence, once a diagnosis is established, emergent cholecystectomy is to be undertaken to prevent perforation with biliary peritonitis and the subsequent sepsis, which results in significant morbidity and mortality [16,51,59]. Laparoscopic cholecystectomy for GBT is not considered more difficult than the operation conducted for usual acute cholecystitis and has excellent outcomes [47]. In the current review, the treatment was surgical in 43 (97.7%) and non-surgical in 1 (2.3%). The approach to surgical treatment was laparoscopic in 32 (72.7%), including one robot-assisted, and open/laparotomy in 11 (25%), and procedures involved detorsion of GB followed with cholecystectomy (n=39, 90.7%), percutaneous decompression of GB followed with cholecystectomy (n=1, 2.3%), cholecystectomy (n=2, 4.7%), and partial cholecystectomy with staplers (n=1, 2.3%). The first successful laparoscopic cholecystectomy for GBT was reported in 1994, and since then, it has emerged as the approach of choice [1]. Detorsion of the gallbladder before clipping of the cystic duct and artery reduces the risk of bile duct injuries[5]. Bekki et al. [60] published a case study of their experiences with CBT in 2017 and concluded that laparoscopic cholecystectomy, rather than open cholecystectomy, would be the gold-standard treatment choice upon diagnosis confirmation. Garciavilla et al. [6]

had also asserted in 2010, that whenever GBT is suspected, it should be promptly resolved laparoscopically.

One patient in the current series where non-surgical management was adopted was reported by Yoshida et al. [15] and is unique. A 90-year-old female presented with loss of appetite, lower back pain, abdominal pain, and fever for 30 days, and a CT scan could not visualize the GB but detected a twisted GB neck in continuity with a 10 cm encapsulated abscess, reaching the anterior abdominal wall. Percutaneous drainage of the abscess and antibiotics successfully managed the case. Remarkably, post-treatment CT showed complete resolution of the abscess, but the GB itself was no longer visible. In the previous literature, Aharoni et al. [61] have reported a successful diagnosis and non-surgical detorsion of GBT by endoscopic retrograde cholangiopancreatography (ERCP).

On surgical exploration, there were features of gangrene /necrosis in 37 (84.1%) cases and were confirmed on histopathological analysis of the retrieved specimen, pointing towards a delay in diagnosis. There were, however, no cases of perforation and biliary peritonitis. The direction of torsion was mentioned in 31 (70.5%) cases, and the ratio of counterclockwise to clockwise was 2:1. The magnitude of torsion was mentioned in 27 (61.3%) cases, and it ranged from 180 to 720 degrees, with most cases having a 360- or 180-degree twist. Torsion is termed as incomplete, in which rotation is less than 180 degrees, or complete, in which rotation is greater than 180 degrees; all the cases in this review were complete. Regarding the direction, it has been traditionally linked to the precise location of GB and its posteriorly lying organ, and it is believed that the clockwise rotation is secondary to the gastric and duodenal peristalsis, whereas anticlockwise rotation occurs because of colonic peristalsis [62].

The postoperative phase was eventful in 2 (4.7%) cases in the current review. One patient suffered from hospital-induced delirium, and in another, there was a left parietal infarct, leading to a prolonged hospital admission. There were no mortalities, though the mortality rate with GBT is 6%, according to literature [1]. It is conceivable that early diagnosis and intervention can lower the morbidity and mortality associated with GBT because, based on Reilly et al.'s review of the literature [1], the deaths linked to GBT occurred in elderly patients with multiple comorbidities, and none of the reported deaths occurred in patients who had a confirmed preoperative diagnosis of GBT.

Conclusion:

Gallbladder torsion is a rare but potentially life-threatening disorder that should be considered during evaluation of acute abdomen, particularly in the thin elderly female patients. Due to lack of awareness, preoperative diagnosis is uncommonly made even after the recent advances in diagnostic imaging modalities. Cholecystectomy is mandatory whenever the diagnosis is suspected or confirmed by imaging, and the laparoscopic approach is safe in most of the cases. Delay in diagnosis and management increases morbidity and mortality. There is a need to enhance awareness about this disorder among the healthcare professionals.

References:

1. Reilly DJ, Kalogeropoulos G, Thiruchelvam D. Torsion of the gallbladder: a systematic review. HPB (Oxford). 2012;14(10):669-672.
2. Yokoi T, Miyata K, Yuasa N, Takeuchi E, Goto Y, Miyake H, Kobayashi Y, Ito T. Twisted cystic artery disclosed by 3-dimensional computed tomography angiography for torsion of the gallbladder. Am J Surg. 2011;201(5):e33-e34.
3. Wendel AV. A case of floating gallbladder and kidney complicated by cholelithiasis with perforation of the gallbladder. Ann Surg 1898;27:199–202.
4. Keplinger KM, Bloomston M. Anatomy and embryology of the biliary tract. Surg Clin North Am. 2014 Apr;94(2):203-217.
5. Farhat W, Mabrouk MB, Ammar H, Mizouni A, Said MA, Lagha S, Ben Cheikh Y, Gupta R, Moussa M, Ali AB. Gallbladder volvulus: A case report and review of the literature. Int J Surg Case Rep. 2019;60:75-78.
6. Garciavilla PC, Alvarez JF, Uzqueda GV. Diagnosis and laparoscopic approach to gallbladder torsion and cholelithiasis. JSLS 2010;14(1):147-151.
7. Zillman JC, Aodish S, Dobratz TC, Swaney P, Stivers J. Twists and Turns: Gallbladder volvulus in an elderly patient. Cureus. 2024 Jul 29;16(7):e65661.
8. Mittal K, Panthi S, Donahue T, Kevorkian N. Gallbladder volvulus: a rare case of pre-operative diagnostic quandary. Adv Surg Sci. 2024;12(1):36-42.
9. Vo NT, Le VT, Nguyen QV. Gallbladder volvulus misdiagnosed as acute acalculous cholecystitis: A case report. Int J Surg Case Rep. 2024 Aug;121:109955.
10. Portilla-Rojas E, Baquero-Castro V,

Ebratt A, Cabrera-Vargas L F, Marroquin L M . Gallbladder volvulus as a diagnostic contender in acute abdomen: case report. SN Compr. Clin. Med. 2024; 6, 110.

11. Tiep CM, Ninh TP, Hung ND, Nga NTT, Toan NM, Hung PN, Chuc DV. Gallbladder volvulus in a 5-years old Vietnamese female: A case report. Clin Case Rep. 2024 Apr 7;12(4):e8743.

12. Tadesse MM, Sefu MS. Gallbladder volvulus in pediatric age: Case report. Int J Surg Case Rep. 2024 Jun;119:109664.

13. Ren H, Liu H, Liu X, Wei H, Tian P. Case report: Rare floating gallbladder torsion in a child. Front Med (Lausanne). 2024 May 30;11:1407716.

14. Nuyts J, Vanhoenacker C, Vellemans J, Aertsen M, Miserez M. Gallbladder torsion: a rare cause of acute abdomen in a 12-month-old child. Acta Chir Belg. 2024;124(1):62-65.

15. Mohammed AA. Laparoscopic cholecystectomy for gall bladder volvulus: a report of an original case with review of literature. Case Rep Gastrointest Med. 2024 Nov 4;2024:9319605.

16. Keller J, Best S, Boatright C. Gallbladder Torsion: A Rare but Critical Diagnosis. Kans J Med. 2024 Mar 15;17:16-17.

17. Yoshida R, Tanaka S, Nakamura T, et al. A case of gallbladder abscess caused by torsion that completely disappeared following drainage. Radiol Case Rep. 2024;19(9):3999-4002.

18. Sidhu K, Seyfi D, Crawford M, Watson G. Gallbladder volvulus in an elderly female with severe kyphoscoliosis. Cureus. 2023 Mar 16;15(3):e36256..

19. Mohamed Ali H, Wahab ERA, Damaj A, Moussawi B, Audi W, Haidar M, Badra Y. Intraoperative Diagnosis of Gallbladder Volvulus. Case Rep Surg. 2023 Oct 31;2023:1194077.

20. Matías-García B, Sainz-Azara C, Mendoza-Moreno F, Díez-Alonso M, Gutiérrez-Calvo A. Gallbladder Volvulus in an elderly patient: a case report and review of literature. Cureus. 2023 Sep 13;15(9):e45167.

21. Daly T, Byrne J, Aftab F. Gallbladder torsion with gangrenous cholecystitis: a case report. J Surg Case Rep. 2023 May 13;2023(5):rjad252.

22. Chugh J, Davis B, Sandoval J, Soliman B. Gallbladder volvulus masquerading as acute cholecystitis: a case report. Cureus. 2023 Nov 8;15(11):e48529.

23. Beatty AS, Kulendran K, Iswariah H, Chandrasegaram MD. Gallbladder volvulus with preoperative and intraoperative imaging. J Surg Case Rep. 2023 Feb 17;2023(2):rjad048.

24. Tabbikha O, El Israwi D, Yehya H, Al Bitar J, Bitar H. Gallbladder volvulus diagnosed intraoperatively: Case report. Int J Surg Case Rep. 2023;113:109026.

25. Uemura S, Maeda H, Obatake M, Namikawa T, Kitagawa H, Fujieda Y, Nishimoto Y, Morishita Y, Fujieda M, Hanazaki K. Laparoscopic cholecystectomy for gallbladder torsion in a 3-year-old child. Acute Med Surg. 2021;8(1):e722.

26. Armistead CW, Favors LE, Mejia VA. Gangrenous cholecystitis from gallbladder volvulus with a hiatal hernia. Am Surg. 2022;88(4):804-806.

27. Miyata T, San-Nomiya Y, Nagayama T, Kin R, Nishiki H, Hashimoto A, Fujii Y, Miura S, Kaida D, Tomita Y, Nakamura N, Miyashita T, Fujita H, Ueda N, Takamura H. Preoperative diagnosis of gallbladder torsion by magnetic resonance cholangiopancreatography: A case report. Clin Case Rep. 2022 Feb 23;10(2):e05487.

28. Wu T, Huang W, He B, Guo Y, Peng G, Li M, Bao S. Acute abdominal disease associated with gallbladder torsion recovered after cholecystectomy: a rare case report and literature review. Ann Transl Med. 2022 May;10(10):616.

29. Ogawa C, Tsuji S, Katsura D, Zen R, Kasahara M, Hoshiyama T, Tokoro S, Hayashi K, Murakami T. Gallbladder torsion in pregnancy: a case report and literature review. J Obstet Gynaecol. 2022 Oct;42(7):3384-3386.

30. Keeratibharat N, Chansangrat J. An unusual presentation of acute cholecystitis due to a gallbladder volvulus in a young female: a case report and review of the literature. Cureus. 2022 Jan 15;14(1):e21275.

31. 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.

32. Lim LX, Mahin HH, Burnett D. Gallbladder volvulus: An unexpected "twist". Radiol Case Rep. 2022 Mar 25;17(5):1755-1759.

33. Kalyanasundaram S, Fernando S, Atypical presentation of cholecystitis with torsion of the gallbladder diagnosed preoperatively in an unusual

location, BJR|Case Reports, 2022;8 (1):20210141.

34. Uemura S, Maeda H, Obatake M, Namikawa T, Kitagawa H, Fujieda Y, Nishimoto Y, Morishita Y, Fujieda M, Hanazaki K. Laparoscopic cholecystectomy for gallbladder torsion in a 3-year-old child. Acute Med Surg. 2021 Dec 22;8(1):e722.

35. Mejri A, Arfaoui K, Rchidi J, Omry A, Mseddi MA, Saad S. The deceitful diagnosis of gallbladder volvulus: A case report. Int J Surg Case Rep. 2021 Jul;84:106114.

36. Doxey S, Nawabi P, Pagnotta C, Smith S, Harper C, Gazzetta J. Incidental Finding of Gallbladder Torsion During Laparoscopic Cholecystectomy. Cureus. 2021 Sep 17;13(9):e18058.

37. Dhafer H, Meryam M, Mouna C, Benzarti Y, Yassine J, Chiraz C, Anis BM. Acute cholecystitis due to a gall bladder torsion. Int J Surg Case Rep. 2021 Sep;86:106272.

38. Baig Z, Ljubojevic V, Christian F. The diagnostic dilemma of a gallbladder volvulus: An unusual case report and review of the literature. Int J Surg Case Rep. 2021 Mar;80:105614.

39. Croce P, Licata S. Gallbladder volvulus: a case report. J Med Case Rep. 2021 Oct 9;15(1):494.

40. Chin X, Ng JY. Gallbladder Volvulus: An Uncommon Twist in Biliary Pathology. Cureus. 2021 Dec 16;13(12):e20469.

41. Cecire J, Sutherland A, Das KK. Gallbladder torsion masking as acalculus cholecystitis: a review of two cases including unsuccessful management with percutaneous cholecystostomy. J Med Cases. 2021 Jun;12(6):223-225.

42. Shah N, Ballecer E, Hanna I, Levin G, Khalife ME. Gallbladder volvulus presenting as acute appendicitis. Cureus 2021; 13(4): e14484.

43. Ahluwalia A, Allaway MGR, Giga S, Curran RJ. Torsion of the gallbladder: a rare but important differential to consider when treating acute cholecystitis non-operatively. BMJ Case Rep. 2021 Jan 6;14(1):e237842.

44. P Sai Krishna, R D R Somasekar, A Siva Sankar, Unexpected intraoperative finding of gallbladder torsion. Journal of Surgical Case Reports. 2021 ;12:478.

45. Bouzas Cardaci M, Bivoleanu CV. Gallbladder volvulus, a rare cause of acute abdomen, a case report. Int J Surg Case Rep. 2020;75:81-84.

46. Hong Duc P, Hong Van P, Quang Huy H . A gallbladder volvulus presenting as acute cholecystitis in a young woman. Cureus 2020; 2(7): e9435.

47. Bergeron E, Désilets E, Do XV, McNamara D, Chergui S, Bensoussan M. A case of torsion of the gallbladder suspected with SPECT-CT: review and recommendations. Case Rep Surg. 2020 Jan 4;2020:8687141.

48. Chai JS, Wang X, Li XZ, Yao P, Yan ZZ, Zhang HJ, Ning JY, Cao YB. Presentation of gallbladder torsion at an abnormal position: A case report. World J Clin Cases 2020; 8(12): 2667-2673.

49. Najmadini M, Rezaei M. Gallbladder torsion: A case report. J Surg Trauma 2020; 8 (3) :119-121.

50. Lau WY, Fan ST, Wong SH. Acute torsion of the gall bladder in the aged: a re-emphasis on clinical diagnosis. Aust N Z J Surg. 1982;52(5):492-494.

51. Ferguson HJ, Bhalerao S. Gallbladder torsion presenting as chest pain. Ann R Coll Surg Engl. 2010;92(3):W25-W26.

52. Nakao A, Matsuda T, Funabiki S, Mori T, Koguchi K, Iwado T et al. Gallbladder torsion: case report and review of 245 cases reported in the Japanese literature. J Hepatobiliary Pancreat Surg 1999; 6:418–421.

53. Dasyam AK, Koo J, Stahlfeld Miller M, Sell HW Jr, Tublin ME. The cystic duct knot sign: case report with description of a new ultrasound sign of gallbladder torsion. Emerg Radiol. 2015;22(4):445-447.

54. Chou CT, Chen RC, Yang AD, Wu HK. Gallbladder torsion: preoperative diagnosis by MDCT. Abdom Imaging 2007; 32:657–659.

55. Chung JC, Song OP, Kim HC. Gallbladder torsion diagnosed by MDCT and MRCP. Abdom Imaging 2010; 35:462–464

56. Tajima Y, Tsuneoka N, Kuroki T, Kanematsu T. Clinical images. Gallbladder torsion showing a “whirl sign” on a multidetector computed tomography scan. Am J Surg. 2009;197(1):e9-e10.

57. Usui M, Matsuda S, Suzuki H, Ogura Y. Preoperative diagnosis of gallbladder torsion by magnetic resonance cholangiopancreatography. Scand J Gastroenterol. 2000;35(2):218-222.

58. Wang GJ, Colln M, Crossett J, Holmes RA. “Bulls-eye” image of gallbladder volvulus. Clin Nucl Med.

1987;12(3):231-232.

59. Kunisek L, Gudelj M, Zelić M, Kršul D, Kunišek J. Acute gallbladder torsion with gangrene and cholelithiasis – a rare condition. Acta Clin Croat. 2016 Dec;55(4):671-674.

60. Bekki T, Abe T, Amano H, Fujikuni N, Okuda H, Sasada T, Yamaki M, Kobayashi T, Noriyuki T, Nakahara M. Complete torsion of gallbladder following laparoscopic cholecystectomy: A case study. Int J Surg Case Rep. 2017; 37:257-260.

61. Aharoni D, Hadas-Halpern I, Fisher D, Hiller N. Torsion of the fundus of gallbladder demonstrated on ultrasound and treated with ERCP. Abdom Imaging. 2000 May-Jun;25(3):269-271.

62. Short A R, Paul R G. Torsion of the gallbladder. Br J Surg 1934; 22 (86);301–309.