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Role of ultrasonography for acute cholecystic conditions in the Emergency room

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Abstract

The aim of this study was to analyse the performance of ultrasonography in the diagnosis of gallbladder conditions requiring surgical intervention. **Material and methods:** We performed an observational retrospective study for the assessment of ultrasound in patients having symptomatic gallbladder lithiasis. **Results:** The study group included 179 patients with a mean age of 59.31 ± 15.82 years. The Kruskal Wallis test showed statistically significant differences (KW, p=0.00003) between the mean thickness of the gallbladder wall found in the 4 morphological types of cholecystitis. The statistical significance analysis using "Risk Ratio"(RR) and "Odd test"(OR) showed an increased risk in patients having documented gallbladder lithiasis to develop catarrhal cholecystitis (RR=1.19; OR=1.32, 95% CI 0.71 - 2.44). For the diagnosis of gallbladder lithiasis during acute cholecystitis, we found a 100% sensitivity, 98.7% specificity, with a 98.7% PPV, 100% NPV and a 93.39% method accuracy. For the diagnosis of various types of acute cholecystitis, we found a 89.99% sensitivity, 84.44% specificity, 88.31% PPV, 86.09% NPV, with a 87.35% method accuracy. **Conclusions:** Ultrasonography is a method of high accuracy in the diagnosis of gallbladder lithiasis (93.39%) and its complication - acute cholecystitis (87.35%). The risk analysis for the occurrence of gallbladder complications and the increased risk for developing a severe form of acute cholecystitis in patients without documented lithiasis proves the essential contribution of ultrasonography in optimizing emergency surgical decision and therapy.

Key words: emergency ultrasound, acute cholecystitis, gallbladder lithiasis

Rezumat

Scopul studiului a fost de a analiza performanţa ecografiei în diagnosticul patologiei de colecist cu indicaţie chirurgicală. **Material şi metodă:** Studiul a fost de tip retrospectiv observaţional evaluând rolul ecografiei la pacienţii cu patologie litiazică de veziculă biliară, simptomatică, care s-au prezentat în U.P.U. a Spitalului Clinic de Urgenţă "O. Fodor" în perioada 6 decembrie 2005 – 30 decembrie 2006. **Rezultate:** Lotul examinat a cuprins un număr de 179 de pacienţi cu vârsta medie de: 59.31 ± 15.82 ani. Testul Kruskal Wallis a evidenţiat diferenţe semnificative statistic (KW, p=0.00003) între grosimea medie a peretelui veziculei biliare la cele 4 forme morfopatologice de colecistită. Analiza semnificaţiei statistice utilizând "Risk Ratio"(RR) şi "Odd test"(OR) a arătat un risc crescut pentru pacienţii cunoscuţi cu litiază biliară de a dezvolta forma cataralâ (RR=1.19; OR=1.32, 95% CI 0.71 - 2.44). Pentru diagnosticul litiazei biliare în context de colecistită acută s-a obţinut o sensibilitate a metodei de 100%, specificitate de 98.7%, VPP de 98.7%, VPN de 100%, cu o acurateţe a metodei de 93.39%. În cazul diagnosticului formelor acute de colecistită s-a demonstrat o sensibilitate de 89.99%, cu specificitate de 84.44%, VPP de 88.31%, VPN de 86.09%, cu o acurateţe a metodei de 87.35%. **Concluzii:** Ecografia este o metodă cu acurateţe crescută în diagnosticul litiazei biliare (93.39%) şi a complicaţiei de tip colecistită acută (87.35%). Analiza riscului de a prezenta o complicaţie a litiazei biliare şi riscul crescut de a avea o formă severă de colecistită acută la pacienţii necunoscuţi litiazici demonstrează aportul esenţial al ecografiei în optimizarea terapiei chirurgicale în urgenţă.

Cuvinte cheie: ecografia de urgenţă, colecistită acută, litiază biliară

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Introduction

The clinical signs and symptoms suggestive of acute biliary conditions causing patients to present in the Emergency room are: upper abdominal pain, fever, nausea, vomiting, anorexia, jaundice, sometimes accompanied by altered bowel transit. These are nonspecific symptoms and usually require differential diagnosis between acute conditions of variable severity and chronic conditions,

requiring surgical or conservative therapy. The imaging techniques, depending on their diagnostic accuracy and accessibility, allow the evaluation of the potential morphopathological cause of clinical symptoms.

The incidence of emergencies of biliary-pancreatic etiology in the Emergency Department of the "O. Fodor" Clinical Emergency Hospital, studied retrospectively over a 13 month period, (December 2005 – December 2006), was 4.79% (759 patients) (unpublished data) (unpublished data). The difficulties encountered in diagnosing and managing these cases lead to the initiation of this retrospective study on the contribution of ultrasonography (US) in triage and in selecting the grade 0 or 1 emergencies, as well as on the various risk factors. The gallbladder diseases were the most frequent emergencies encountered. The percentage of patients having acute gallbladder conditions requiring surgery was 35.04%.

Aim of the study

Our study aimed to analyse the correlation between the ultrasonographic image and the intraoperatory aspect of the gallbladder in patients with acute cholecystitis previously diagnosed ultrasonographically in the Emergency Department. The objectives of the study were: 1. analysing the performance of US in diagnosing gallbladder conditions requiring surgery; 2. assessing the performance of US in detecting the lithiasic etiology; 3. analysing the performance of US in assessing complications; 4. evaluating the performance of US in assessing evolutive risk.

Material and method

We performed an observational retrospective study assessing the role of US in patients with symptomatic gallbladder lithiasis presenting in the Emergency Department of the "O. Fodor" Clinical Emergency Hospital. The study, performed between the 6th of December 2005 – the 30th of December 2006, included 179 patients with ages between 17 and 90, who had accepted the surgical intervention (cholecystectomy). *The patient selection criteria* were: clinical, ultrasonographical and biochemical signs of complicated gallbladder lithiasis requiring surgery. *Clinical criteria:* typical symptoms on arrival for biliary colic, biliary colic with jaundice, acute pancreatitis. *Ultrasonographic criteria:* for biliary lithiasis associated with acute cholecystitis, gallbladder hydrops, choledocal lithiasis, acute pancreatitis with biliary microlithiasis. The ultrasonographic diagnosis of *acute cholecystitis* was established on the following 5 criteria: distended gallbladder, parietal thickening, the presence of lithiasis, positive Murphy sign, pericholecystic collection. Surgery was indicated upon meeting 2 criteria out of 5. *Gallbladder hydrops* was defined by the presence of a distended gallbladder (long axis over 100 mm, short axis over 40 mm), appearing under tension, possibly finding a calculus lodged in the infundibulum. *The biochemical criteria* associated with lithiasic complications were: leucocytosis (>10.000/mm^3), hepatocytolsis (ASAT/ALAT > 46 U/l), hyperbilirubinemia (> 1.1 mg/dl), increase serum amylases (> 100 UI/l). *The ultrasonographic examination* was performed in the first 2 hours from presentation in the Emergency Room, using the Pico Sonoace and Sonosite 180 plus portable ultrasound machines, with convex transducer and 3-5MHz frequency. The biochemical investigations were performed in the Central Laboratory of the 3rd Medical Clinic, on the emergency analyzer. The surgical interventions were carried out in the 3rd Surgical Clinic; the surgical team of the clinic observed the gallbladder aspect, walls and content and appreciated the cholecystitis type, and recorded them in the surgical protocol. The data were recorded in an evidence chart and then transferred to an Excel database.

We performed a complex, descriptive and inferential statistical analysis, in order to assess the statistical significance of US in the diagnosis of surgical complications of biliary lithiasis. The descriptive statistical analysis consisted of the calculation of dispersion and centrality indices: means and standard deviations for numerical variables, and frequency tables for the qualitative variables. The inferential statistics consisted of analysing qualitative and quantitative variables with the following tests: the nonparametric Chi Square (χ^2) test, the nonparametric Kruschal Wallis test, the Odds Ratio test for logistic regression analysis of risk comparison. We also analysed the statistical significance of the study according to power/ analysed the power of the study ($p<0.05$). In order to visually display the conclusions of different analyses we used "bar, pie, box plot" charts, according to the results and the type of each analysis.

All patients and control subjects gave consent to participate in the study, which was approved by the local Ethics Committee.

Results

The study group included 179 patients with a mean age of 59.31 ± 15.82 years. The descriptive analysis of patient distribution in age and gender groups showed (fig 1) an increased incidence of cholecystitis in female patients, regardless of age group, the difference decreasing with age (table I). For the group of patients diagnosed ultrasonographically

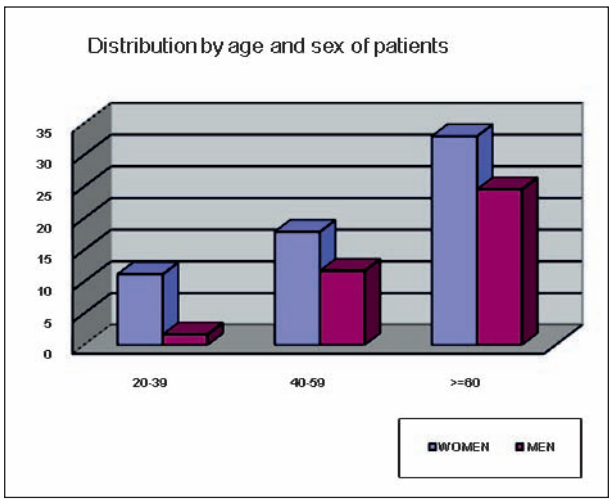


Fig 1. The incidence of acute cholecystitis by age and sex

Table I. Study group (179 patients) characteristics

Age Group	W (%)	M (%)	W/M
20-39	11.17	1.67	6.68
40-59	17.87	11.73	1.52
≥60	32.96	24.58	1.34

(W: women; M: men)

with acute cholecystitis in the Emergency Room we then analysed the pathologic type as found intraoperatory and noticed an important percentage (48%) of complicated, phlegmonous and gangrenous forms compared with catharral forms (37%) and chronic cholecystitis.

In order to correlate the clinical aspects upon admission with the severity of acute cholecystitis, we analysed the symptoms and objective signs as recorded in the Emergency Room and compared them with the pathologic aspect of the gallbladders observed during sugery. We observed that the clinical symptoms upon admission did not correlate with the severity of the pathologic type. The most frequent symptoms encountered in the severe forms were right upper quadrangle pain and nausea associated with vomiting, which are totally nonspecific symptoms and may lead to diagnostic errors (fig 2).

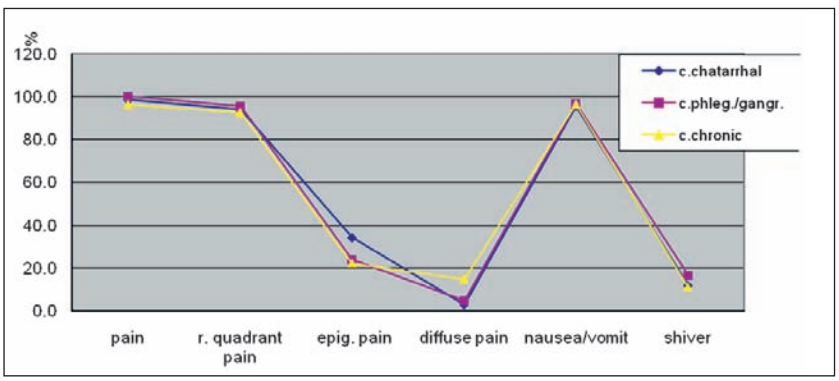


Fig 2. Analysis of the incidence of clinical symptoms of patients with acute cholecystitis at presentation in ED correlated with the morphopathological form of cholecystitis

The ultrasonographic examination performed in the emergency setting offers information on the parietal alterations, such as parietal thickening, "double contour" inflammatory aspect and pericholecystitis or the presence of pericholecystic collections (fig 3). We remarked that parietal thickening is the most frequent finding observed in the group of acute cholecystitis patients. The "double contour" aspect, associated with pericholecystitis, was found most frequently in patients having gangrenous cholecystitis (20.25% and 9.49%, respectively). In the cases of chronic cholecystitis, the most frequent sign was parietal thickening (10.76%), and the "double contour" aspect, induced by acute inflammation, was only observed in 5.7% of the patients (table II). The statistical

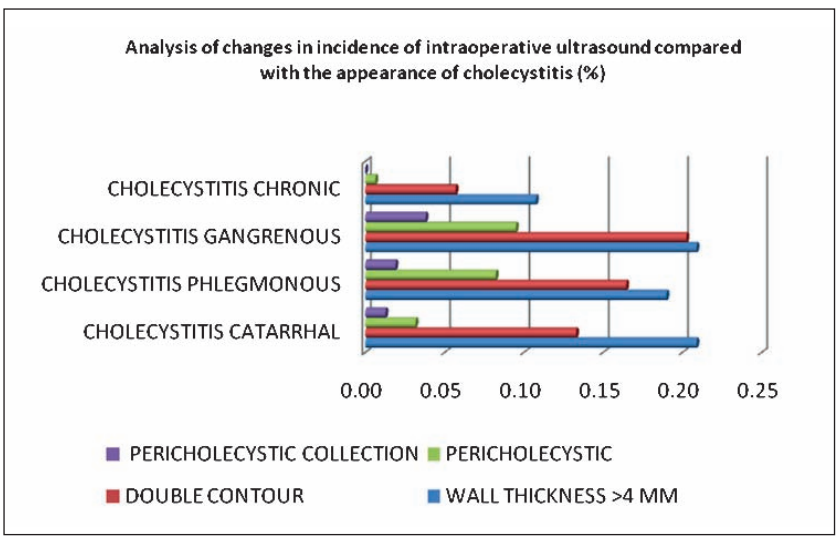


Fig 3. The incidence of pathological changes of the gallbladder wall US diagnosed in emergency reported in the morphopathological form of cholecystitis

Table II. Incidence of parietal changes observed in US examination of gallbladder and reported to the total number of patients with cholecystitis

US changes \ US diagnosis	Catarrhal cholecystitis	Phlegmonous cholecystitis	Gangrenous cholecystitis	Chronic cholecystitis
Wall thickness >4 mm	20.89	18.99	20.89	10.76
Double contour	13.29	16.46	20.25	5.70
Pericholecystitis	3.16	8.23	9.49	0.63
Pericholecystic collections	1.27	1.90	3.80	0.00

Table III. Analysis of mobile versus immobile incidence of gallstones in the gallbladder in US examination depending on morphological forms of cholecystitis diagnosed postoperatively

US gallstones \ Morphological diagnosis	Catarrhal cholecystitis	Phlegmonous/gangrenous cholecystitis	Chronic cholecystitis
Mobile gallstones	22.98	27.33	8.70
Immobile gallstones	13.66	20.50	6.83
Mobile/immobile gallstones	1.68	1.33	1.27

analysis, using the Chi-Square test, of parietal ultrasonographic findings, showed statistically significant differences between the catarrhal form compared to the chronic form (χ^2, $p < 0.000002$). The comparative analysis between the catarrhal and phlegmonous forms proved not statistically significant (χ^2, $p < 0.248252$) and the comparative analysis of the ultrasonographic alterations found in catarrhal and gangrenous forms had a weak statistical significance (χ^2, $p < 0.040197$). We analysed the mean wall thickness in each of the 4 cholecystitis types, based on the ultrasonographic observation of gradual thickening of the gallbladder wall during the inflammatory process. Using the nonparametric Kruskal Wallis test, we found statistically significant differences (KW, p=0.00003) among the mean thickness of the gallbladder wall in each of the 4 types of cholecystitis. We noticed deviations from the mean in cases belonging to each type (fig 4).

We assessed ultrasonographically in the emergency setting the mobility of the calculi in the gallbladder and its impact on the type of cholecystitis, as was ascertained after surgery. In catarrhal cholecystitis 22.98% calculi were mobile and 13.06% were fixed, in phlegmonous and gangrenous forms 27.33% were mobile and 20.50% were fixed, and in chronic cholecystitis only 8.70% calculi were mobile and 6.83 were fixed. It became apparent that the mobile calculi are responsible for an important part of the cases (59.01%), but nevertheless without any significant differences among catarrhal (22.98%) and phlegmonous/gangrenous (27.33%) types. We calculated the ration between the mobile/immobile calculi involved in producing the pathologic types of cholecystitis and obtained values higher than 1, but without any significant differences (table III). We also observed the high incidence of phlegmonous/gangrenous types (20.50%) in cases having immobile calculi.

Another parameter submitted to analysis was the concordance between the ultrasonographic estimation of gallstone size and their actual size, as measured after surgery (fig 5).

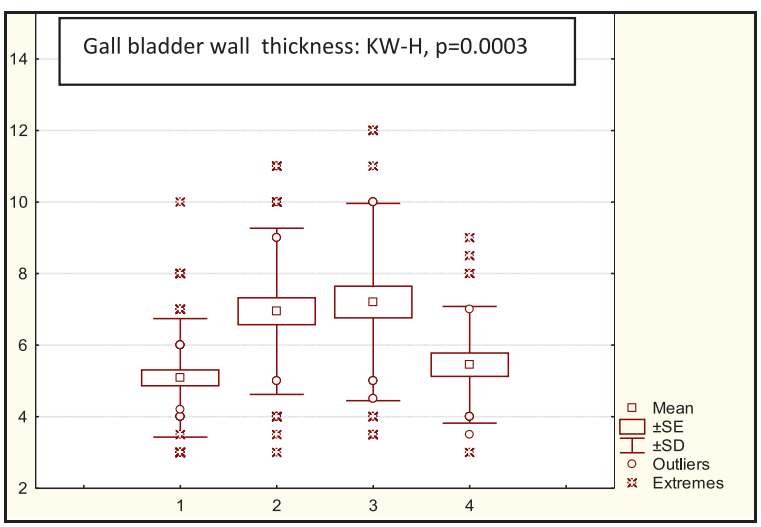


Fig 4. Mean bladder wall thickness assessed by ultrasonography in 4 morphological forms of cholecystitis: 1 - catarrhal; 2 - flegmonous; 3 - gangrenous; 4 - chronic

Table IV. Consistency of assessing the size of gallbladder stones by ultrasound and postoperative measurements

Gallbladder stones size assessed by US and surgery (%)	Absent	<5 mm	5-10 mm	0-10 mm	>10 mm	<5, >10 mm
Total no. of patients with gallbladder stones – US diagnosis	1.22	26.83	17.07	20.73	21.34	12.80
Consistency 100%	0.00	13.41	5.49	6.10	12.80	2.44
underrated	0.00	0.00	7.93	9.15	8.54	4.27
overrated	1.22	13.41	3.66	5.49	0.00	6.10

We found a good correlation between the sizes measured by each method (40.24%); we found, however, a significant percentage of ultrasonographic underestimation of gallstone size (29.89%). There was also a degree of overestimation (29.88%), especially for microlithiasis under 5 mm in size (table IV). It is worth mentioning, for the practical point of view, the low percentage of alithiasic patients with parietal findings of cholecystitis where the ultrasonographic method yielded a diagnosis of microlithiasis (1.22%).

In the assessment protocol of the cases, we also included the personal history of lithiasis. It lead to the observation that patients with unknown lithiasis who developed severe forms of cholecystitis (phlegmonous and gangrenous) had a higher rate of morbid associations, such as diabetes mellitus and hypertension. The mean age for the occurrence of acute and chronic cholecystitis as a complication of biliary lithiasis was observed to be lower in patients with a known history of lithiasis. The statistical significance analysis using "Risk Ratio" (RR) and "Odds ratio test" (OR) showed an increased risk for patients with positive lithiasis history to develop the catarrhal (RR=1.19; OR=1.32, 95% CI 0.71 - 2.44) and the chronic form of cholecystitis (RR=1.53; OR=1.66 95% CI 0.72 – 3.79), respectively. The subgroup of patients with negative lithiasis history prior to the admission in the Emergency Department have a higher risk of developing a phlegmonous/gangrenous form (RR=1.32; OR=1.69 95% CI 0.93 – 3.09).

We also assessed the contribution of US in the Emergency Department in the diagnosis of biliary lithiasis and its complication, acute cholecystitis. For the diagnosis of lithiasis during an acute cholecystitis, we found a 100% sensitivity, a 98.7% specificity, 98.7% PPV, 100% NPV, with a method accuracy of 93.39%. The LR "+" value was 76.9, showing a high probability for the presence of lithiasis if the US was positive. For the diagnosis of acute cholecystitis forms, we found a 89.99% sensitivity, 84.44% specificity, 88.31% PPV, 86.09% NPV, with a method accuracy of 87.35%.

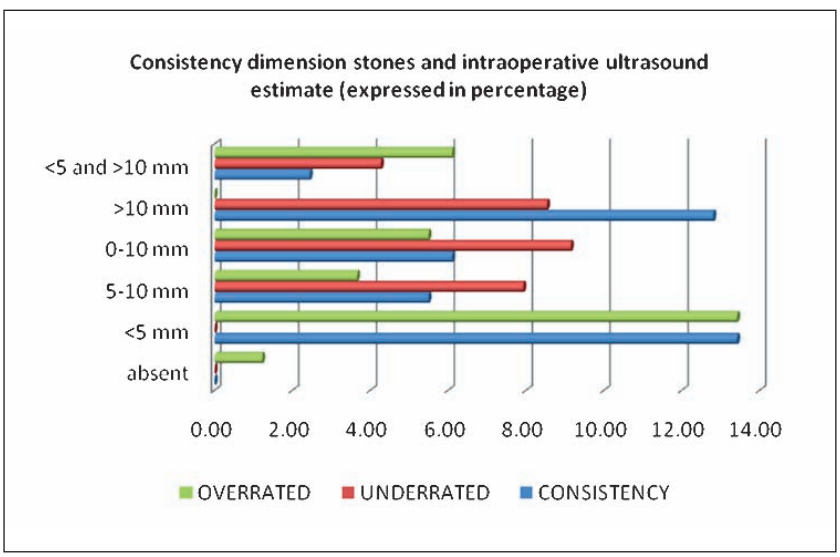


Fig 5. Estimation the size of gallbladder stones using ultrasound method and postoperatively measurement at patients with cholecystitis

Discussions

Acute cholecystitis is the most frequent complication of biliary lithiasis, with the incidence increasing with age, as demonstrated after analysing the number of admissions and cholecystectomies in patients over the age of 60 [1,2]. US is one of the methods most frequently used in the Emergency Department for the diagnosis of acute cholecystitis; however, several studies have stressed the limitations of the method related to the operator's expertise, the ultrasound machines used and the possibility of performing the investigation at the bedside [3-6]. There are also studies proving the accuracy and ad-

vantages of US performed in emergency as compared to hepatobiliary scintigraphy [7,8] or computer tomography [9]. Summers and colab. showed a better accuracy of US performed in the emergency setting than that of the same method performed by radiologists for the identification of surgical conditions such as acute cholecystitis [10]. *The originality of the study resides in the correlation of the clinical and ultrasonographic aspects with intraoperatory findings, as well as in the analysis of sonographic accuracy in the diagnosis of different forms of acute lithiasic cholecystitis.*

The incidence of acute cholecystitis was higher in female patients, but the sex difference tended to decrease with age (20 – 39 years: F/M=6.68, ≥60 years: F/M=1.34). The results of the present study confirm the variations in lithiasis incidence, as stated in the epidemiological literature [11,12]. We also found an increased incidence of the disease in patients from an urban areas, but the difference decreased in the over 60 age group. The biliary colic persisting for 1 to 5 hours is very suggestive of acute cholecystitis. We recorded the symptoms and clinical signs found in the emergency examination and compared them to the pathologic types found during surgery and we noted their lack of specificity. The objective signs were present in a lower percentage of the patients than that mentioned in literature, especially in what concernes the Murphy sign (93%) and fever (45%) in the severe forms [13,14]. There is, however, an important proportion of patients presenting with few symptoms, such as upper abdominal pain, especially in the right upper quadrangle (88.6%), nausea and vomiting, symptoms that frequently require imaging evaluation [15,16].

The surgical indication for biliary colic or for the clinical suspicion of acute cholecystitis can be validated after confirming ultrasonographically the lithiasis and its impact on the gallbladder aspect [17,18]. We therefore analysed ultrasonographically the alterations of the gallbladder wall and assessed their sensitivity in the discrimination of the pathologic type of acute cholecystitis, as diagnosed during surgery. There are ultrasonographic evidences that significantly discriminate between the parietal changes found in acute catarrhal cholecystitis and chronic cholecystitis (χ^2, p=0.00002). There was no pericholecystic collection identified in any of the patients with chronic cholecystitis found during surgery.

It was documented that the sonographic feature most frequently encountered in patients with acute cholecystitis is parietal thickening, also described din literature as correlating with the inflammatory process [19,20]. The statistical analysis of the mean gallbladder wall thickness, measured for each of the pathologic types, showed statistically significant differences between them (KW, p=00003). These results form ultrasonographic evidences for the differentiation of inflammation severity: catarrhal cholecystitis (fig 6a, 6b) – 4.64 mm; phlegmonous cholecystitis (fig 7) – 6.68 mm; gangrenous cholecystitis (fig 8) – 7.28 mm. The results of our study confirm the literature data showing statistically significant correlations between the parietal dimensions described ultrasonographically and those measured during surgery by Bingener et al [19]. Chen and colab. reported an increase in the conversion risk at a sonographically-measured parietal thickness of more than 6 mm [21,22].

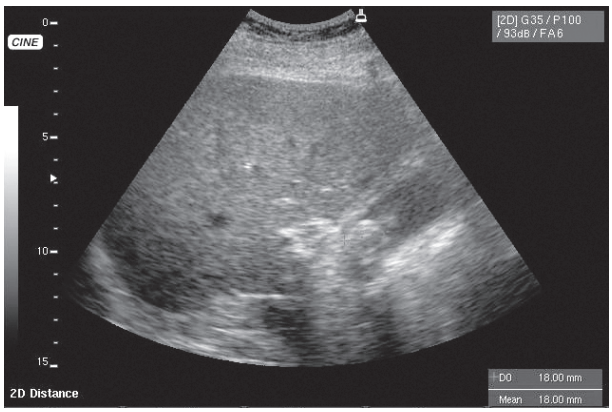


Fig 6a. Intercostal oblique section- catarrhal acute cholecistitis form

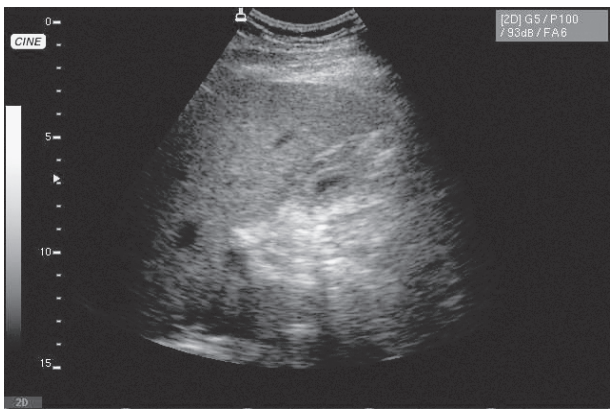


Fig 6b. Intercostal oblique section-double contour aspect – acute hepatitis

The literature data describe gallstones lodged in the infundibulum as a favourising factor of inflammation [23]. The correlation between the ultrasonographic aspect of immobile calculus with the severity of cholecystitis, as diagnosed during surgery, was therefore analysed. The result was an increased incidence of acute inflammatory processes in cases with mobile gallstones, without any statistically significant differences between the catarrhal (22.98%) and the phlegmonous/gangrenous

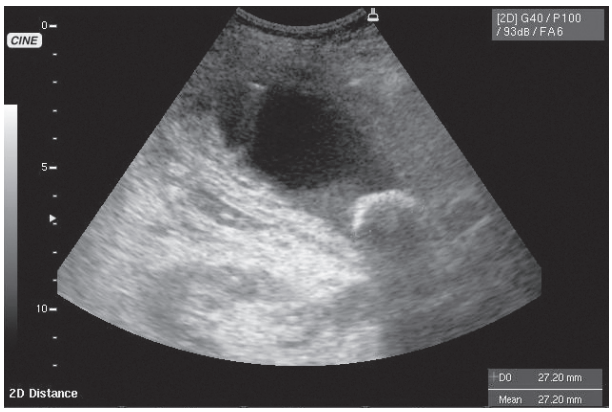


Fig 7. Intercostal oblique section-acute gallblader stone cholecistitis –gangrenous form

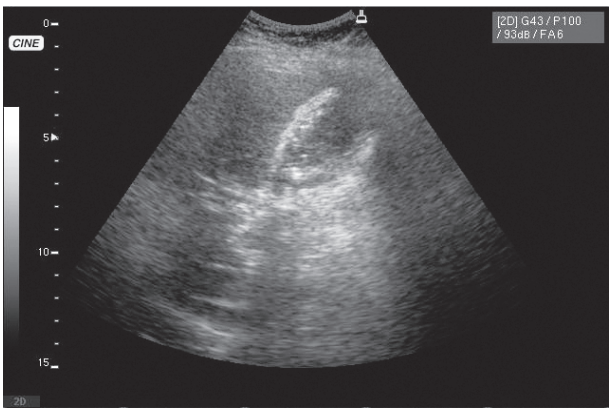


Fig 8. Subcostal oblique section- acute gallblader stone cholecistitis – phlegmonous form

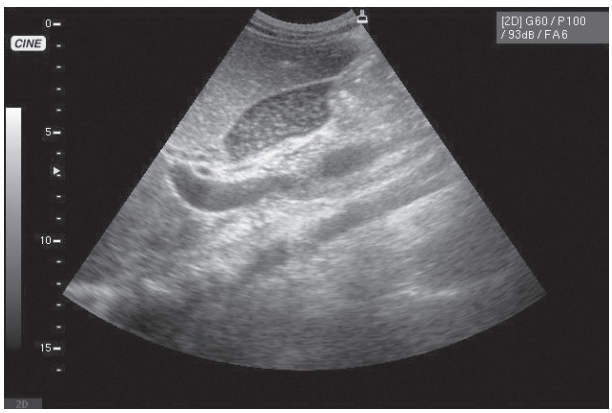


Fig 9. Intercostal oblique section- gallblader - sludge with hyperechoic elements

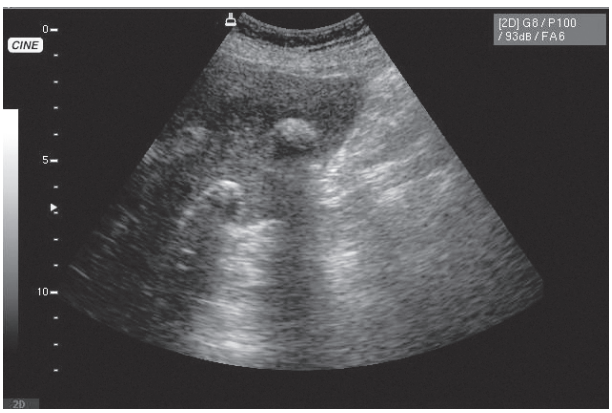


Fig 10. Intercostal oblique section- echogenic bile fluid with suspended calculi

forms (27.33%). Nevertheless, a high incidence of severe, phlegmonous/gangrenous forms was recorded in the subgroup of patients with immobile calculi on the ultrasonographic examination (20.50% out of a total percentage of 40.99%).

In a low proportion of patients (1.22%), we found on US suggestive aspects for microlithiasis and cholecystitis; during surgery, only calcic bile was found in these patients, but no gallstones; this confirms the literature data, describing the role of sludge and cholesterol crystals (fig 9, fig 10) in inducing acute cholecystitis [24]. The gallstones under 5 mm lead to the highest overestimation rate (29.88%), explainable by the summation phenomenon, correlated with the resolution of the ultrasound machine and the expertise of the examinThe already published data mention the fact that most patients with acute cholecystitis had previous history of symptomatic lithiasis [25]. In our group, the patients with unknown gallbladder lithiasis predominated (55.11%); they developed severe forms of acute cholecystitis more frequently and had a higher rate of morbid associations than those with already documented lithiasis. The patients with positive history of lithiasis tended to belong to the chronic cholecystitis group.

The regressive statistical analysis confirmed the risk of patients without positive history for lithiasis to develop severe forms of acute cholecystitis (RR=1.32; OR=1.69) and, respectively, for those with documented lithiasis to develop catarrhal (RR=1.19, OR=1.32) and chronic forms (RR=1.53, OR=1.66). The risk analysis confirms the role of emergency US in the assessment of patients with clinical suspicion for acute cholecystitis, especially in patients without previous history of lithiasis. The increased risk the latter have in developing severe forms of acute cholecystitis stresses the contribution of US in optimising surgical therapy, in accordance with actual protocoles for the acute approach of lithiasis complications such as cholecystitis [26,27].

In our study, we analysed the contribution of US in the diagnosis of biliary lithiasis during acute cholecysti-

tis; we found a method accuracy of 93.39%, with LR + of 76.9, values concordant to the literature data reported by experienced radiologists [28,29]. For the diagnosis of acute forms of cholecystitis, we found a 87.35% accuracy, a 84.44% specificity, and 86.09% negative predictive value, in accordance with the literature data [19,30]. The results of the ultrasonographic examination and their accuracy are evidences for the use of the method in confirming biliary lithiasis and its inflammatory complication, acute cholecystitis.

Conclusions

1. The incidence of acute cholecystitis in the studied group was higher in patients from urban areas, with a predominance of severe, phlegmonous/ gangrenous forms (48%).
2. The symptoms and signs found during emergency examination were not specific for the severity of any of the particular type of acute cholecystitis.
3. The statistical analysis of the mean parietal thickness as assessed ultrasonographically in each pathologic type of acute cholecystitis showed statistically significant differences (KW, p=00003), and allowed to discriminate the severity of inflammation in cholecystitis.
4. US is a method of high accuracy for the diagnosis of biliary lithiasis (93.39%) its complication, acute cholecystitis (87.35%).
5. The ultrasonographic assessment of gallstone size had a 40.24% concordance with the sizes measured during surgery.
6. The risk analysis for lithiasis complications and the high risk for patients without previous lithiasis history to develop severe forms of acute cholecystitis stresses the essential contribution of US in optimising surgical therapy.

US can be used as a first intention examination in the Emergency Department for the triage of patients with complicated biliary lithiasis requiring surgical therapy.

Conflict of interest: absence of conflict of interest

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