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Ultrasonography of gallbladder in surgical patients with a prolonged stay (> 14 days) in the intensive care unit

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Background. *The aim of this study was to establish the incidence of abnormal ultrasonographic (US) findings of gallbladder (GB) in surgical patients with the prolonged stay in the intensive care unit (ICU) and to correlate these findings with the severity of illness.*

Methods. *In the prospective study fifty-seven (57) adult surgical patients (male 66%; age 49±18 yr.) with the prolonged stay in ICU (>14 days) were analyzed. In all patients the US examination was performed on the 15th day of their stay in ICU. The presence of the following US findings was analyzed: GB wall thickening (?4 mm), biliary sludge, GB hydrops, striated GB wall and pericholecystitic fluid. The severity of illness was also evaluated on the 15th day of the stay in ICU using Simplified Acute Physiology Score (SAPS II).*

Results. *At least one abnormal US finding was found in 36 (63%), patients with GB wall thickening in 32 (56%), biliary sludge in 23 (40%), pericholecystitic fluid in 9 (16%), hydrops of GB in 7 (12%), and striated GB wall in 4 (7%) cases, respectively. Two to five US findings were found in 20 (35%) patients, three to five in 12 (21%), four to five in 10 (18%), while all five US findings were present in 4 (7%) cases. The patients with one and more US findings had significantly higher SAPS II than the patients who presented regular US findings of the GB (36±9 vs. 28±7; $p < 0.01$). The patients with two and more US findings had higher SAPS II than those with one or none US criteria (40±8 vs. 29±6; $p < 0.001$), while the patients with three and more had higher SAPS II than those with two, one or none (41±8 vs. 31±9; $p < 0.001$). The patients with four or five US findings had higher SAPS II than those with three or less (42±11 vs. 31±6; $p < 0.001$) while the patients with all five had higher SAPS II than all others (45±10 vs. 32±9; $p < 0.001$). A significant positive correlation between the number of US findings and SAPS II was present ($r = 0.57$; $p < 0.001$).*

Conclusions. *More than half of all surgical patients with the prolonged stay in ICU have GB abnormalities seen by ultrasonography; and it is in direct correlation with the severity of illness.*

Key words: gallbladder diseases ; ultrasonography; postoperative complications; intensive care units

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Introduction

Acute acalculous cholecystitis (AAC) is a serious complication in the treatment of critically ill patients. The incidence, published up to now varies from 0.2% up to 18% in patients

treated in intensive care unit (ICU).[1-3] Such variability is due to different incidences of AAC in different patients but also due to dissimilar criteria for the diagnosis of AAC. Ultrasonography (US) remains the method of choice for the diagnosis of AAC because it is a non-invasive, relatively inexpensive and transportable technique.[1-4] However, some recently published studies suggest that in critically ill patients it is not an optimal diagnostic method due to the low sensitivity and the high percentage of abnormal US findings of gallbladder (GB).[5,6]

The patients with the prolonged stay (>14 days) in ICU represent a specific group of critically ill patients with much higher incidence of complications and worse outcome but with a significantly more expensive treatment vs. other ICU patients.[7,8] On the other hand, those patients have many risk factors for abnormal US findings of GB as for example: total parentereal nutrition, hypoalbuminaemia, splanchnic ischemia/reperfusion injury, analgosedation, mechanical ventilation, infection, shock, sepsis, multiorgan failure, etc.[1,2]

The main aim of this study was to establish the incidence of abnormal US findings of GB in surgical patients with the prolonged stay (> 14 days) in ICU. The second point of this study is to correlate US findings of GB with the severity of illness in these patients at the time of the US examination.

Patients and methods

In the prospective study 60 consecutive adult surgical patients who stayed more than two weeks (14 days) in ICU were included. All were admitted in ICU after the urgent (36 cases) or elective major surgery (24 cases). Before we started the study we excluded patients under 18 years of age, neurosurgery or cardiac surgery patients, these with earlier cholecystectomy as well as the patients who at present hospitalization underwent pancreatobiliary surgery. During the study three cases of gallbladder calculosis, verified by the US examination were excluded. Finally, 57 surgical ICU patients (male 66%; age 49±18 yr.) were analyzed. Gallbladder US was performed in all patients on the 15th day of the stay in ICU. The patients were estimated by real-time ultrasound scan using a 3.5-5 MHz curved transducer (Hitachi 515 EUB; Tokyo, Japan). All examinations were performed by the same investigator (A.Š.). Standard subcostal cross-section was used, and the following US abnormality (*i.e.* criteria for AAC) were evaluated:[2-6, 9-12]

1. *Gallbladder wall thickening.* GB wall thickening was defined as thickening of GB wall in transverse diameter ≥ 4 mm.

2. *Increase of GB volume (hydrops)*. Increase of GB volume was defined as distension of GB in the longest diameter of ≥ 10 cm or when measured volume of GB was ≥ 100 ccm (ellipsoid formula was used for GB volume measurement).13

3. *Biliary sludge.* Biliary sludge was defined as an echogenic intraluminal sedimentation and gravity-dependence formation in GB.

4. *Layering or target phenomenon of GB.* Layering or target phenomenon of GB was defined as a linear hypoechogenic »halo« within the wall structure (»striated GB wall«).

5. *Pericholecystitic fluid.* Pericholecystitic fluid was defined as an anechogenic layer around the GB.

The severity of illness was estimated in all patients on the 15th day of their stay in ICU, using Simplified Acute Physiology Score II (SAPS II).[14] The mean simplified acute physiology score II (SAPS II) was 33±10.

Statistical analysis

All values are presented as number and percentages or mean value ± standard deviation. A statistical analysis was done with software Statistica 6.0 (StatSoft. inc.), using Mann-Whitney U for comparisons of quantitative

Table 1. The incidence of ultrasonography (US) criteria of acute acalculous cholecystitis (AAC) in 57 surgical ICU patients

	Yes	No
At least 1 US criteria for AAC	36 (63%)	21 (37%)
At least 2 US criteria for AAC	20 (35%)	37 (65%)
At least 3 US criteria for AAC	12 (21%)	45 (79%)
At least 4 US criteria for AAC	10 (18%)	47 (82%)
5 US criteria for AAC	4 (7%)	53 (93%)

Table 2. The frequency of abnormal ultrasonographic (US) findings of gallbladder (GB) in 57 surgical ICU patients

Abnormal US findings	Yes	No
GB wall thickening (%)	32 (56%)	25 (44%)
Biliary sludge (%)	23 (40%)	34 (60%)
Hydrops (distension) of GB (%)	7 (12%)	50 (88%)
Pericholecistitic fluid (%)	9 (16%)	48 (84%)
Striated GB wall (%)	4 (7%)	53 (93%)

variables of unpaired samples and Pearsonís moment for the estimation of correlation coefficients.

Results

The results are presented on tables 1, 2 and 3. At least one abnormal US finding of the GB was found in 36 (63%) patients, with GB wall thickening in 32 (56%), biliary sludge in 23 (40%), pericholecystitic fluid/oedema in 9 (16%), hydrops of GB in 7 (12%), and striated GB wall in 4 (7%) patients, respectively. Two to five US criteria of AAC were found in 20 (35%) patients, three to five in 12 (21%), four to five in 10 (18%), while all five US criteria were present in 4 (7%) cases. The patients with one and more US findings of AAC have had significantly higher SAPS II than the patients who presented regular US findings of the GB (36±9 vs. 28±7; $p < 0.01$). The patients with two and more US findings of AAC have had higher SAPS II than those with one or none criteria of AAC (40±8 vs. 29±6; $p < 0.001$), while the patients with three and more had higher SAPS II than those with two, one or none criteria (41±8 vs. 31±9; $p < 0.001$). The patients with four or five US criteria had higher SAPS II than those with three or less criteria (42±11 vs. 31±6; $p < 0.001$) while the patients with five had higher SAPS II than all others (45±10 vs. 32±9; $p < 0.001$). A significant positive correlation between the number of US criteria of AAC and SAPS II was present ($r = 0.57$; $p < 0.001$) (Figure 1).

Discussion

Acute acalculous cholecystitis is highly dangerous, often lethal complication during the intensive treatment of critically ill surgical patients.[1-3] Ultrasonography, as a noninvasive, simple, inexpensive and transportable method represents initial and most often used diagnostic option in the evaluation of critically ill patients with suspect AAC in ICU setting.[2-4] In many publications during the last 25 years US criteria for AAC are clearly defined: GB thickening, hydrops of GB, biliary sludge, striated GB wall and pericholecystitic fluid.[2-6, 9-12] Examining those criteria, one by one or summing them up, the majority of authors stressed the overall security of US. Hence, this bedside imaging method is nowadays accepted in many ICU as a basic diagnostic modality when evaluating critically ill patients with suspect AAC. [2-4, 9-12] Nevertheless, in majority of this studies the incidence of one or more abnormal US findings of GB were much higher than the expected incidence

Table 3. The relationship between ultrasonography criteria (US) of acute acalculous cholecystitis (AAC) and severity of illness (SAPS II) in 57 surgical ICU patients

	SAPS II		P value
	No	Yes	
≥ 1 US criteria for AAC	28±7	36±9	< 0.01
≥ 2 US criteria for AAC	29±6	40±8	< 0.001
≥ 3 US criteria for AAC	31±9	41±8	< 0.001
≥ 4 US criteria for AAC	31±6	42±11	< 0.001
≥ 5 US criteria for AAC	32±9	45±10	< 0.001

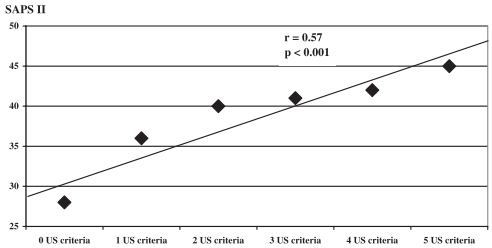

Figure 1. The correlation between the number of positive ultrasonography criteria (US) of acute acalculous cholecystitis (AAC) and severity of illnes (SAPS II) in 57 surgical ICU patients.

of AAC. For example, in the study of Molenat *et al* 50% of patients presented at least one from three major US criteria for AAC (GB thickening, hydrops of GB and biliary sludge was considered as major criteria); in the study of Imhof *et al* 80% of patients, while Helbich *et al* registered 90% of patients who had at least one US criteria for AAC.[9-11] Recently published investigations of Boland *et al* and Puc *et al* completely confirmed those results but with somewhat different conclusions.[5,6] Boland *et al* found in a heterogenic group of 44 critically ill patients 84% with one positive US criteria for AAC, 57% with three positive and 14% with all five positive US criteria.[5] The authors assume that many of findings are false positive and because of that conclude that US has a very limited value in diagnosing AAC in ICU patients.[5] On the other hand, Puc *et al* in the retrospective analysis of 62 critically ill injured patients found the very low sensitivity of US diagnostics of solely 30% (6/20) concluding that US has insufficient sensitivity to justify its use in diagnosing AAC in ICU patients.[6]

The patients with the prolonged stay (> 14 days) in ICU have many risk factors for abnormal US findings of gallbladder (GB), for example total parentereal nutrition, hypoalbuminaemia, splanchnic ischemia/reperfusion injury, analgosedation, mechanical ventilation, infection, shock, sepsis, multiorgan failure, etc.[5,9-12] To our knowledge this is the first study which analyses the incidence of abnormal US findings of GB in critically ill surgical patients with the prolonged ICU stay (> 14 days). Our results are similar to previously mentioned results. We also had over 60% of patients with at least one US criteria for AAC, 21% with three criteria and 5% with all five criteria. If we correlate these results with the expected incidence of AAC, which is approximately 1%,[1,2] we can conclude that on one patient with a true positive result (*i.e.* all five criteria) there are minimally four patients with false positive US findings. Thus, our research on a group of surgical patients with a prolonged ICU stay, confirms the conclusions of Puc *et al* that US has the unsatisfactory sensitivity in diagnosing AAC in ICU setting.[6]

In the presented study we have correlated US findings with the severity of the illness at time of the US examination (*i.e.* 15th day of stay in surgical ICU). The mean value of SAPS II in our patients was 33±10 with 63% of abnormal US findings. In the previously mentioned study published by Molenat *et al* the average SAPS I of patients was 13±3 (which corresponds to the approximate value of SAPS II about 35)[14] with 50% abnormal US findings.[9] In recent investigations of Mariot *et al* SAPS II of patients included in study was 36±11 (the criteria for inclusion in the study were positive clinical and laboratory symptoms of AAC) with even 85% of cases with abnormal US findings of GB while the sensitivity of US diagnostics was about 50%, respectively.[15] Summing up the results of our and these studies we may assume that at least 50% of patients staying in ICU with SAPS II over 35 will have abnormal US findings of GB independently of real AAC incidence. Moreover, in our study we found a statistically relevant positive correlation between positive US findings and the severity of illness, meaning that the patients with more positive US criteria for AAC had on average higher values of SAPS II. This result shows that the severity of illness is one of predictors for abnormal US findings of GB. Similar results were previo-

usly published by Pelinka *et al* who found the severity of illness as an independent predictor for abnormal US findings of GB in selective group of trauma patients.[16] Therefore, we can assume that abnormal US findings of GB will be more often possible, indeed more probable in patients who are more severely ill. However, this thesis should be adequately investigated and confirmed on various groups of ICU patients.

Summing up, more than half of all surgical patients with the prolonged stay in ICU have GB abnormalities seen by US, and these abnormalities are in a direct correlation with the severity of illness. At the end we can conclude that due to a great number of false positive results and low sensitivity US is generally of little benefit for the diagnosis of AAC in critically ill patients with the prolonged stay (>14 days) in ICU.

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