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ULTRASOUND MEASUREMENT OF THE GALLBLADDER WALL THICKNESS IN THE ASSESSMENT OF THE RISK OF CONVERSION FROM ELECTIVE LAPAROSCOPIC CHOLECYSTECTOMY TO OPEN SURGERY — OLKUSZ COUNTY EXPERIENCE

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The aim of the study was to assess the risk of intraoperative difficulties, conversion and biliary-intestinal fistula during laparoscopic cholecystectomy on the basis of an ultrasound-measured gall-bladder wall thickness.

Material and methods. A prospective study was conducted in 50 patients undergoing laparoscopic cholecystectomy for chronic gallstone-induced cholecystitis. To calculate the relationships between categorical variables, a chi-square (χ^2) independence test was used, and the results were interpreted for the significance threshold of $\alpha = 0.05$.

Results. The relationship between the gall-bladder wall thickness and the occurrence of intraoperative difficulties in the analysed set is deterministic (AUC = 1), and the wall thickness of ≥ 5 mm allows to predict their occurrence as soon as at the stage of diagnostic evaluation ($p < 0.001$). In addition, the ultrasound-measured GB wall thickness is a good predictor of conversion (AUC = 0.976; 95% CI 0.444–0.975; $p < 0.001$) and biliary-intestinal fistula (AUC = 0.935; 95% CI 0.121–0.738; $p = 0.001$).

Conclusions. The results allow prediction of technically difficult laparoscopic cholecystectomies in patients with CCh, and selection of the right surgical team helps to reduce the number of conversions and possible complications. In addition, bearing in mind the above results in everyday practice should facilitate planning and increase effectiveness in the operating room.

Key words: laparoscopic cholecystectomy, conversion, gall-bladder wall thickness, gall-bladder ultrasound

Abbreviations used in the text

ACh – acute cholecystitis, **CCh** – chronic cholecystitis, **LCh** – laparoscopic cholecystectomy, **CBD** – common bile duct, **GB** – gall-bladder

Towards the end of the 19th century the German surgeon Langenbuch performed the first cholecystectomy (1). In 1985, Mühe removed the gall-bladder using a laparoscope (2), and in 1987, Mouret performed the first ever laparoscopic cholecystectomy with injection of air into the peritoneal cavity (3). Since then, we have been witnessing a spectacular advancement of low-invasive surgical techniques, laparoscopic cholecystectomy being the most common procedure performed in general surgery departments (4, 5). Laparoscopy owes its popularity to minor tissues damage, short hospitalisation time, rapid convalescence, good cosmetic effect and lower treatment costs as compared with the traditional technique (6, 7). Thanks to these features, laparoscopic cholecystectomy has become the procedure of choice in the treatment of symptomatic cholecystolithiasis (8).

In addition to numerous advantages, also technical limitations of laparoscopy should be mentioned, which – in the presence of chronic inflammation resulting in pericystic adhesions and conglutination – increase the risk of undesirable conversion from laparoscopic cholecystectomy to open surgery (9, 10). There are no clear criteria confirming the necessity of conversion. Abnormal exposure of the operative field and difficulties in identifying anatomical structures within the Calot's triangle

(an effect of post-inflammatory anatomical abnormalities and atrophy of the avascular space separating the hepatic parenchyma from the gall-bladder wall, which is so convenient for skeletonisation) (11) are the cause of intraoperative complications, biliary duct injury included (12, 13, 14). In order to limit the number of adverse events, preoperative assessment of the biliary tract topography on MRI or ERCP or intraoperative cholangiography may be performed. Despite unquestionable advantages of the aforementioned procedures, the costs and the risk of possible complications have restricted their use to specific cases (15).

Preoperative stratification of the risk of conversion to open cholecystectomy is another way to reduce intraoperative complications. Abandoning this low-invasive operative technique should not be treated as an error or complication but rather as an attempt to avoid biliary duct injury, which results from the operator's experience (16, 17, 18). The most common risk factors for conversion include a thickened gall-bladder wall, past acute cholecystitis, diabetes mellitus, past upper gastrointestinal tract surgeries, age > 65 years and male sex (19-26). Despite numerous papers, varied research methods (one-step vs two-step treatment of ACh, differing surgical techniques) and heterogeneous health educational background of the study populations (e.g. access to and utilisation of tertiary prevention) render specification of inclusion criteria impossible, and the intraoperative complication risk has to be assessed by the operator. There are more complex scales which, due to the number of components and the need for intraoperative assessment, have not come into use in everyday clinical practice (27).

MATERIAL

From the perspective of a county hospital, it is justified to describe the preoperative risk of conversion from LCh and occurrence of intraoperative difficulties using available and inexpensive measurement parameters, reproducible and thereby likely to be used in everyday clinical practice, whose value would depend on the severity of the chronic inflammatory process, regardless of population differences. Preoperative classification of patients into a high risk group would be an objective factor facilitating the surgeon's decision on possible conversion. Furthermore, it would facilitate the preparation of patients for longer convalescence and the modification of the operating room scheduling as well as improve the patient safety by selecting an experienced operating team able to cope with unclear anatomy, bleeding from the gall-bladder bed or gall-bladder perforation (19, 28).

One of the factors contributing to the assessment of the risk of intraoperative difficulties during laparoscopic cholecystectomy is the severity of pericystic inflammation as reflected by the GB wall thickness. However, a wide range of 3–7 mm as reported in the literature is impractical and proves varied operator experience, differing inclusion criteria (ACh vs CCh) and inconsistent biliary tract anatomy which make it impossible to come up with one cut-off point (29).

To establish an objective criterion for the risk of conversion from laparoscopic cholecystectomy to an open procedure, a study was conducted to assess its probability depending on the ultrasound-measured gall-bladder wall thickness. The value of the variable analysed is secondary to the chronic inflammatory process responsible for the development of pericystic adhesions which is the most common cause of conversion (6, 22, 23, 25, 29-32). The study included patients with confirmed chronic cholecystitis (CCh) with cholelithiasis as only in this type of disease the GB wall thickness reflects the degree of fibrosis (33, 34). The exclusion criterion was acute cholecystitis diagnosed at admission, with the gall-bladder wall additionally thickened by effusion and preventing the proper assessment of the relationship concerned.

At the stage of formulating the study objective, it was judged that biliary-intestinal fistula is the condition necessitating a definite decision to convert from laparoscopic cholecystectomy to an open procedure. Therefore, the probability of its development in patients with CCh was also estimated in the study. In addition, some factors, i.e. intraoperative bleeding, gall-bladder wall perforation and concrement size and position were omitted as the conversion risk they might entail depends on operator experience and the surgical technique employed.

METHODS

Patient selection

Over the period of 15 months at the Department of General Surgery of the Olkusz County Hospital a cohort study was conducted in 50 patients qualified for deferred elective laparoscopic cholecystectomy (> 6 weeks from the onset of gall-stone-induced ACh symptoms) (35, 36) due to chronic cholecystitis with cholelithiasis. The inclusion criteria included at least one past episode of gall-stone-induced biliary colic necessitating intervention in the Emergency Department and the lack of clinical and laboratory features of acute cholecystitis meeting the Tokyo criteria (positive Chelmonski sign, severe pain in the right upper quadrant in the three days preceding admission, positive Murphy sign, body temperature > 37.5°C, leukocytosis > 10 thousand/L and CRP > 3 mg/dL) (16). The study excluded patients with jaundice, cirrhosis of the liver, dilated CBD and diseases which are an absolute contraindication for laparoscopic cholecystectomy (37, 38). After every procedure, intraoperative difficulties, conversion included, were recorded, and in the postoperative period, the patients were followed-up for two months in the outpatient setting.

Ultrasound

In the 24 hours preceding surgery, every patient underwent an abdominal ultrasound scan with the Logiq C5 Premium unit. The scans were performed by one physician who assessed the thickness of the anterior gall-bladder wall (i.e. from the side of hepatic parenchyma) on an transhepatic ultrasonographic image (29). The measurement was done at the widest fragment of the GB wall, which was found while the patient was in supine or lateral decubitus position (33). The GB wall thickness was unknown to the operators during surgery.

Surgical procedure

Surgeries were performed by a group of four surgeons, using the American model of three-person operating team (39), three-port laparoscopic access and Fowler's position (reverse Trendelenburg position) with left-side rotation ±20°. Each of the 50 patients was operated on according to the following scheme: additional infiltration anaesthesia with 1% lidocaine solution at the cutaneous incision sites, introduction of trocars with the injection of air into the peritoneal cavity at 12 mm Hg, removal of pericystic adhesions, skeletonisation of the Calot's triangle structures with visualisation of the Rouviere's sulcus, selective clipping and cutting of the cystic duct and cystic artery, skeletonisation of the gall-bladder from the neck of the gall-bladder and retrieval from the peritoneal cavity, drainage of the subhepatic space. The problem with capturing the fibrotic wall of an enlarged gall-bladder was solved by the introduction of a needle into its lumen followed by decompression. When problems with skeletonisation of the Calot's triangle structures occurred, an additional grasper was introduced for better visualisation of the operative field. If no progress in tissue skeletonisation with the Maryland tool was achieved, operators used an edge of the endoscope suction pump which in some cases served to "bluntly" separate post-inflammatory adhesions from the Calot's triangle structures, allowing to continue the laparoscopic procedure. In the second stage, retrograde cholecystectomy "from the fundus" was attempted (40, 41), and further lack of progress in surgery constituted an indication for consultation with the Department Head as well as for conversion. Consultations with the Department Head were aimed at maintaining reliability of the results by eliminating differences in the surgeons' practical knowledge (42). No intraoperative cholangiograms were performed, and every specimen was histologically examined to rule out neoplastic process. When the decision on conversion was made, every patient was administered 1 g of intravenous cefazolin as part of perioperative prevention. The postoperative two-month follow-up was provided at our Outpatient Surgery Clinic.

RESULTS

After a detailed analysis of data it was ascertained that difficult operative conditions applied only to patients with the gall-bladder wall thickness greater than or equal to 5 mm.

To present a cut-off value with best discriminatory properties in terms of differentiation between patients, e.g. with difficult operative conditions during laparoscopic cholecystectomy, in a clearly empirical manner the gall-bladder wall thickness of 5 mm was considered the best threshold value of the variables analysed. All calculations were done in the R environment, version 3.3.0, and the test results were interpreted for the significance threshold of $\alpha = 0.05$. The aim of the study was to prove two hypotheses:

– intraoperative difficulties occur only in patients with the gall-bladder wall thickness ≥ 5 mm.
– intraoperative difficulties do not occur in patients with the gall-bladder wall thickness < 5 mm.

It is clear that proving the first hypothesis is identical with proving the other hypothesis. The analyses were therefore limited to proving the first hypothesis.

In addition, the study aimed to provide answers to the following research questions:

1. What is the risk of difficulties necessitating conversion, and in particular what is the risk in patients with preoperatively-measured gall-bladder wall thickness greater than or equal to 5 mm?
2. What is the risk of biliary-intestinal fistula, and in particular what is the risk in patients with preoperatively-measured gall-bladder wall thickness greater than or equal to 5 mm?

To calculate the relationships between categorical variables, a chi-square (χ^2) independence test based on Monte Carlo simulation was used on 2,000 samples as some of the expected values, assuming independence of variables, were smaller than 5.

1. Sample description

Table 1 presents descriptive statistics of distribution of the gall-bladder wall thickness. The data revealed right-skewed distribution, i.e. low values were predominant. In fact, only 20% of the study subjects, i.e. 10 individuals, had the gall-bladder wall thickness of not less than 5 mm. In ten patients operative conditions were difficult (tab. 2), which led to conversion in eight cases. Pericystic adhesions were the most common cause of technically difficult surgeries, accounting for 60% of cases with thickened GB wall of ≥ 5 mm. Biliary-intestinal fistulas occurred in the remaining 40% of cases (tab. 3).

2. The gall-bladder wall thickness greater than or equal to 5 mm and the occurrence of intraoperative difficulties

To examine if in the case of the gall-bladder wall thickness equal to or greater than 5 mm intraoperative difficulties always occur, an appropriate cross table was analysed (tab. 4). It was ascertained that the gall-bladder wall thickness is a perfect predictor of their occurrence in the sample in question – all patients with the wall thickness ≥ 5 mm developed complications, while other patients had no complications. For quantitative description of the effect, the Goodman and Kruskal's λ coefficient was used. It assumes the zero value if the variables are independent and 1 – if one variable makes an ideal prediction of the other variable possible. In the case concerned, $\lambda = 1$ for both the columns and rows. The result supports the data presented in tab. 4.

Table 1. Descriptive statistics for the distribution of the gall-bladder wall thickness (n = 50)

Mean	Standard deviation	Minimum	Median	Maximum
3,88	1,41	2	4	8

Table 2. Distribution of technically difficult laparoscopic cholecystectomies (n = 50)

W/o complications	Conversion	Biliary-intestinal fistula with conversion	Other *
40	4	4	2

* this category includes breach of the duodenal serosa and 4-hour duration of laparoscopic surgery due to intestinal adhesions.

Table 3. The causes of technically difficult laparoscopic cholecystectomies

Item	GB wall thickness (mm)	Intraoperative difficulties during LCh
1	6	pericystic adhesions, GB empyema
2	8	biliary-intestinal fistula, gangrenous cholecystitis
3	5	biliary-intestinal fistula
4	5	biliary-intestinal fistula
5	6	biliary-intestinal fistula
6	6	pericystic adhesions, GB empyema
7	6	pericystic adhesions
8	8	pericystic adhesions, GB empyema
9	7	w/out conversion, pericystic adhesions
10	5	w/out conversion, pericystic adhesions

Table 4. The gall-bladder wall thickness greater than or equal to 5 mm and the occurrence of intraoperative difficulties (n = 50)

Gall-bladder wall thickness ≥ 5 mm	Intraoperative difficulties	
	no	yes
No	40	0
Yes	0	10

The χ^2 test showed that the variables are not stochastically independent, $\chi^2(1) = 50$; $p < 0.001$. The results also prove the lack of intraoperative difficulties in patients with the gall-bladder wall thickness of less than 5 mm, which means that they support also the other hypothesis. It should be conclusively stated that the data collected clearly prove the truthfulness of both hypotheses.

2.1. The quality of binary classification of the occurrence of intraoperative difficulties on the basis of the gall-bladder wall thickness

The above results were complemented with a detailed analysis of the quality of prediction of intraoperative difficulties on the basis of the preoperatively-measured gall-bladder wall thickness. In particular, the optimum classification threshold was determined on the basis of the data. The relationship between the gall-bladder wall thickness and the occurrence of intraoperative difficulties in the analysed set is deterministic (tab. 4). Therefore, the area under the ROC curve, which corresponds to the classifier predicting the occurrence of intraoperative difficulties on the basis of the gall-bladder wall thickness, evidently equals 1 (fig. 1).

However, the joint distribution of the gall-bladder wall thickness and the occurrence of intraoperative difficulties warrants a detailed analysis. The distribution may serve to determine the sensitivity and specificity of the classification based on the threshold equal to a given gall-bladder wall thickness in millimetres (tab. 5). Such an analysis shows that the optimum threshold, as determined on the basis of the data collected, for identifying patients likely to develop intraoperative difficulties is indeed 5 mm as it is the only value for which

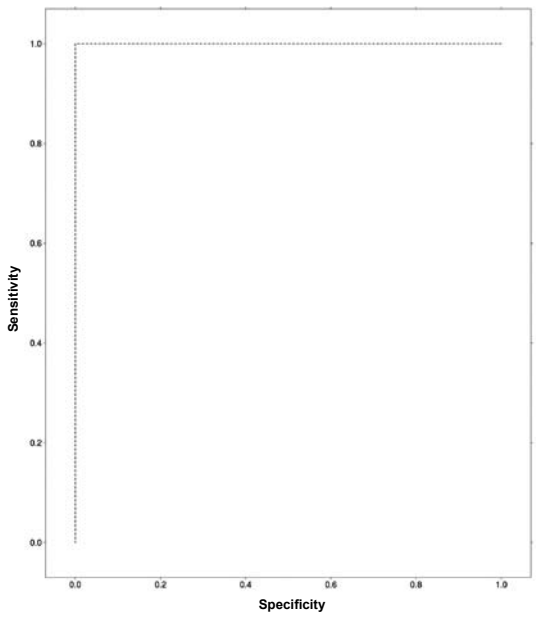

Fig. 1. The ROC curve of the binary classifier predicting the occurrence of intraoperative difficulties on the basis of the gallbladder wall thickness (mm), AUC = 1

Table 5. The joint distribution of the preoperatively-measured gall-bladder wall thickness and the occurrence of intraoperative difficulties (n = 50)

Occurrence of intraoperative difficulties	Preoperatively measured gall-bladder wall thickness (mm)						
	2	3	4	5	6	7	8
No	5	18	17	0	0	0	0
Yes	0	0	0	3	4	1	2
Sensitivity	1,000	1,000	1,000	1,000	0,700	0,300	0,200
SSpecificity	0,000	0,125	0,575	1,000	1,000	1,000	1,000

both sensitivity and specificity equal one. Therefore, it should be emphasised that it is an unambiguous value*.

3. The gall-bladder wall thickness greater than or equal to 5 mm and conversion

Also in this case an analysis of an appropriate cross table was used (tab. 5). Again, the gall-bladder wall thickness and the necessity to convert are not stochastically independent, $\chi^2(1) = 38.09$; $p < 0.001$.

As tab. 6 shows, intraoperative difficulties necessitating conversion occurred in eight patients. They accounted for as much as 80% of all patients with complications. The 95% precise confidence interval calculated on the basis of the binomial distribution was 44.4%–97.5% (fig. 3), with no analysed variable in patients with the GB wall thickness < 5 mm. On the basis of the results obtained, the risk in the entire sample was 16%, with the 95% confidence interval equal to 7.2-29.1%.

3.1. The quality of binary classification of conversion on the basis of the gall-bladder wall thickness

The following results were complemented with a detailed analysis of the quality of prediction of conversion on the basis of the preoperatively-measured GB wall thickness. In particular, determination of the optimum classification threshold was attempted on the basis of the data collected.

Table 6. The gall-bladder wall thickness greater than or equal to 5 mm and the occurrence of intraoperative difficulties necessitating conversion (n = 50)

Gall-bladder wall thickness ≥ 5 mm	Conversion	
	no	yes
No	40	0
Yes	2	8

The ROC curve of the classifier predicting conversion is presented in fig. 2. Area under curve was 0.976. This suggests that conversion may still be very well predicted on the basis of the gall-bladder wall thickness, although not perfectly, as was the case with intraoperative complications.

To determine the optimum classification threshold, the joint distribution of the gall-

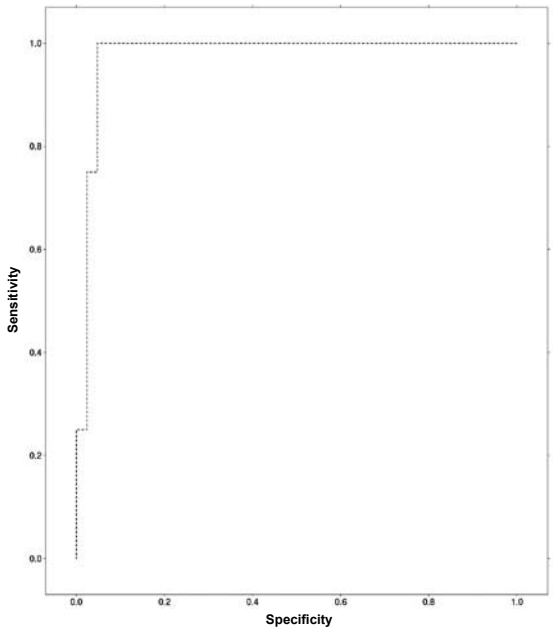

Fig. 2. The ROC curve of the binary classifier predicting conversion on the basis of the gall-bladder wall thickness (mm), AUC = 0.976

* The whole analysis is based on the assumption that the gall-bladder wall thickness is measured to the nearest 1 mm.

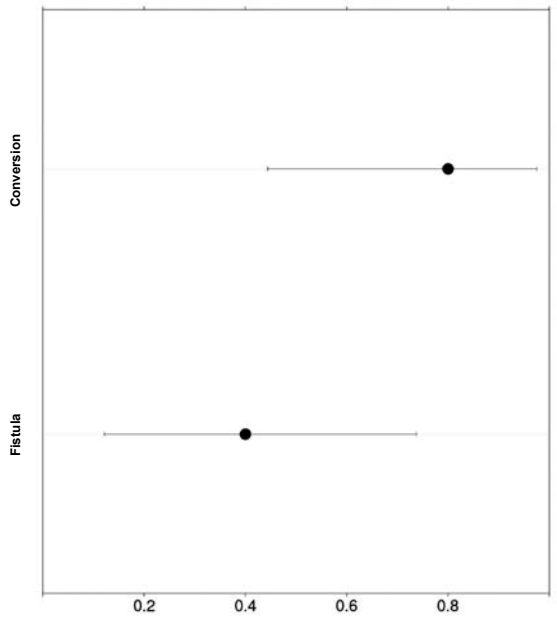

Fig. 3. The risk of conversion and the occurrence of biliary-intestinal fistula in patients with intraoperative difficulties. Also precise 95% confidence intervals based on binomial distribution have been superimposed

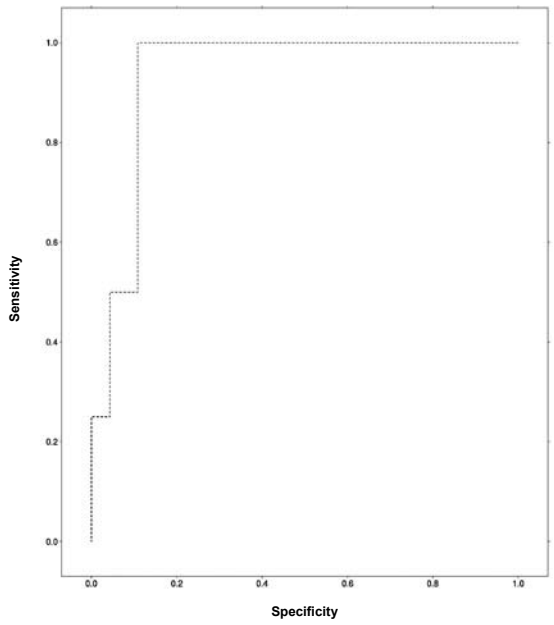

Fig. 4. The ROC curve of the binary classifier predicting the occurrence of biliary-intestinal fistula on the basis of the gall-bladder wall thickness (mm), AUC = 0.935

bladder wall thickness and conversion need to be analysed in detail. The distribution may serve to determine the sensitivity and specificity of the classification based on the threshold equal to a given GB wall thickness in millimetres (tab. 7). In this case, definite determination of the optimum classification threshold is not feasible as there is no threshold with both sensitivity and specificity of not less than any other. Of course, the threshold equal to 5 mm appears to be best as it has sensitivity of 1 and still very high specificity of 0.952. Nevertheless, considering it the optimum threshold would require an in-depth analysis allowing for the "cost" of various classification mistakes.

4. The gall-bladder wall thickness greater than or equal to 5 mm and the occurrence of biliary-intestinal fistula

In answering the other research question, also an analysis of an appropriate cross table was the starting point (tab. 8). Also this time it was ascertained that the variables were not stochastically independent, χ^2 (1)= 17.39; p = 0.001.

As tab. 6 shows, biliary-intestinal fistula occurred in four patients who accounted for 40% of all patients with complications. The 95% precise confidence interval based on the binomial distribution of the percentage was 12.1-73.8% (fig. 3), with no analysed variable

Table 7. The joint distribution of the preoperatively-measured gall-bladder wall thickness and the occurrence of difficulties necessitating conversion (n = 50)

Wystąpienie powikłań / Occurrence of complications	Grubość ściany pęcherzyka żółciowego mierzona przed operacją / Preoperatively-measured gall-bladder wall thickness						
	2	3	4	5	6	7	8
Nie / no	5	18	17	1	0	1	0
Tak / yes	0	0	0	2	4	0	2
Czułość / sensitivity	1,000	1,000	1,000	1,000	0,750	0,250	0,250
Swoistość / specificity	0,000	0,119	0,548	0,952	0,976	0,976	1,000

Table 8. The gall-bladder wall thickness greater than or equal to 5 mm and the occurrence of biliary-intestinal fistula (n = 50)

GGall-bladder wall thickness ≥ 5 mm	Biliary-intestinal fistula	
	no	yes
No	40	0
Yyes	6	4

in patients with the GB wall thickness < 5 mm. In the entire sample the risk was 8%, with the 95% confidence interval equal to 2.2-19.2%.

However, it is worth noting that the set of conversions caused by fistula is a subset of all conversions. That is why the risk of conversion caused by biliary-intestinal fistula in patients undergoing conversion was also assessed. As is clearly seen, the risk was 50% since there were eight patients with conversion and four with conversion and fistula. The 95% precise confidence interval of the risk based on the binomial distribution was 15.7-84.3%.

4.1. The quality of binary classification of biliary-intestinal fistula on the basis of the gall-bladder wall thickness

The above results were complemented with a detailed analysis of the quality of prediction of biliary-intestinal fistula on the basis of the preoperatively-measured gall-bladder wall thickness. In particular, determination of the optimum classification threshold was attempted on the basis of the data collected.

The ROC curve of the classifier predicting the occurrence of biliary-intestinal fistula is presented in fig. 4. Area under curve was 0.935, which suggests that the variables are strongly dependent. However, in comparison with other ROC graphs, the ultrasound-measured GB wall thickness is an effective classifier of general intraoperative difficulties (AUC = 1) and intraoperative difficulties necessitating conversion (AUC = 0.976).

To determine the optimum classification threshold, the joint distribution of the gall-bladder wall thickness and occurrence of biliary-intestinal fistula need to be analysed in detail. The distribution may serve to determine the sensitivity and specificity of the classification based on the gall-bladder wall thickness in millimetres (cf. tab. 9). In this case, definite determination of the GB wall thickness threshold is not feasible as there is no threshold with both sensitivity and specificity not lower than any other. Of course, the threshold equal to 5 mm appears to be best as it has sensitivity of 1 and still very high specificity of 0.869. Nevertheless, considering it the optimum value would require an in-depth analysis allowing for the "cost" of various classification mistakes.

There were seven cases of wound infection in the study. There were no other complications reported in the literature (43), which is most likely related to the small sample size.

DISCUSSION

The aim of the study was to develop an easy and practical method of assessing the risk of intraoperative difficulties and conversion from laparoscopic cholecystectomy to traditional technique. In order to do it, we used a widely available ultrasound measurement of the gall-bladder wall thickness as a feature secondary to the severity of pericystic inflammation in patients with CCh (33, 34).

In order to obtain reliable data, the study group was narrowed down to patients with chronic cholecystitis with cholelithiasis quali-

Table 9. The joint distribution of the preoperatively-measured gall-bladder wall thickness and the occurrence of biliary-intestinal fistula (n = 50)

Occurrence of biliary-intestinal fistula	Preoperatively-measured gall-bladder wall thickness						
	2	3	4	5	6	7	8
No	5	18	17	1	3	1	1
Yes	0	0	0	2	1	0	1
Sensitivity	1,000	1,000	1,000	1,000	0,500	0,250	0,250
Specificity	0,000	0,109	0,500	0,869	0,891	0,956	0,978

fied for deferred elective laparoscopic cholecystectomy (with a history of at least one episode of ACh treated conservatively). In addition, the operator experience in laparoscopic cholecystectomy allowed to limit intraoperative difficulties to borderline states which accounted for 20% of all cases (10 of 50 patients). For comparison, the rates reported in the literature are 32.8-62% (6, 19, 34).

In our study, the gall-bladder wall thickness ≥ 5 mm in CCh patients statistically significantly ($p < 0.05$) increased the risk of intraoperative difficulties and conversion. In two papers concerning elective laparoscopic cholecystectomies the threshold value was 4 mm (6, 22). In contrast to other papers (22, 23, 29, 30, 36, 44), we included only patients with chronic cholecystitis as intramural effusion in the course of ACh, which increases the GB wall thickness, would lead to wrong conclusions. In addition, at our Department, patients with ACh symptoms were treated conservatively (antibiotic therapy, anti-inflammatory drugs, diet) and were scheduled for deferred elective laparoscopic cholecystectomy. Using the two-step management scheme, conversion was necessary in 16% of patients operated on (tab. 2). It is a satisfactory result, given 4.5-50% reported in other papers (18, 19).

Moreover, our results show that patients with a thickened gall-bladder wall of ≥ 5 mm with recurrent episodes of hepatic colics should undergo prompt surgical treatment despite the lack of features of active ACh. Such management reduces the risk of developing biliary-intestinal fistula, which is related to the duration of the inflammatory process and which constitutes an absolute contraindication for laparoscopic cholecystectomy. Furthermore, in this group of patients surgeries should be performed by experienced operators due to the 40% risk of clinically "silent" moderate ACh (according to the Tokyo criteria (16), it includes GB empyema and gangrenous cholecystitis) (tab. 3).

The risk factors for difficult operative conditions during laparoscopic cholecystectomy such as diabetes mellitus, > 5 episodes of hepatic colics lasting > 4 hours, CCh symptoms lasting > 36 months, age and male sex were not taken into account in our study (17, 19, 26, 45-50) because their occurrence reflects the severity of pericystic inflammatory process as assessed on ultrasound. The gall-bladder wall thickness measured in the 24 hours preceding surgery is a sufficient factor allowing accurate patient classification to a high-risk group. The impact of male sex on the risk of conversion should be explained by a prolonged period of conservative treatment of CCh due to the cultural background and related reluctance to see the doctor.

In our material, as in other papers (6, 22-25, 29-32, 44), pericystic adhesions and fibrosis were the most common cause of conversion. In order to limit to the minimum the risk of biliary tract injury, we followed the rule of deferring the clipping followed by cutting the skeletonised Calot's triangle structures until the Rouviere's sulcus and the initial segment of the biliary duct has been spotted. Thanks to this technique, one may make sure that the biliary duct running to the gall-bladder is not in fact a pulled CBD changing its direction in the GB neck region and running to the liver. In the absence of inflammatory reaction, a similar biliary tract anatomy may be seen with a short biliary duct. Other techniques employed in advanced pericystic inflammatory infiltration included puncture with the gall-bladder decompression (51, 52) and the technique of GB skeletonisation from the fundus.

After an analysis of the data, there was an incident of traumatic injury of the biliary tract (Bismuth grade I) at our Department, which was identified and treated intraoperatively. Intraoperative cholangiography would probably allow to dispel doubts as to the biliary duct anatomy. That is why despite numerous technical inconveniences which extend surgery time, we recommend intraoperative radiological assessment of the biliary tract anatomy in selected cases (numerous scars in the Calot's triangle region preventing visualisation of the Rouviere's sulcus).

Such variables as leukocytosis, fever, hypoalbuminaemia and hyperbilirubinaemia were not subject to our study either as their elevated levels accompany acute cholecystitis (43) which was an exclusion criterion in the programme. In addition, varied definitions of ACh are used in the literature, which precludes practical use of the aforementioned factors.

Insufficient number of patients previously treated surgically prevented an assessment of the relationship between peritoneal adhesions and risk of conversion during cholecystectomy, which was reported by some authors (43).

However, it appears that port insertion using the Hasson technique or injection of air into the peritoneal cavity using the Veress needle inserted at the left upper quadrant (Palmer point) ensures safe introduction of surgical instruments into the peritoneal cavity and performing of laparoscopic cholecystectomy.

Standard surgeries are performed through the three-port laparoscopic access, despite the lack of EBM data supporting its superiority in terms of reduced postoperative pain, betted cosmetic effect or shorter hospitalisation time (53). Our management scheme resulted from our department's experience that small number of postoperative wounds has a positive impact on the patient who sees no need to prolong the three-day hospitalisation (which included one postoperative day). In the case of numerous adhesions or a large deposit trapped in the Hartmann pouch area, we introduced an additional grasper which facilitated assessment of the Calot's triangle area.

In the opinion of some authors, concrements measuring over 20 mm and located in the Hartmann pouch hinder normal capturing and positioning of the gall-bladder, which translates into difficulties in skeletonisation of the gall-bladder duct/artery (20, 21, 54). In other papers, perforation of the gall-bladder wall with the concrements falling out into the peritoneal cavity was considered the cause of conversion (19, 36, 54). In our study, we did not notice a direct impact of the two factors on conversion to the traditional surgical procedure. Appropriate capturing and positioning of the gall-bladder with an additional grasper make it possible to finish surgery using the laparoscopic technique. During surgery, several times the concrements fell out through the gall-bladder perforation site, and were retrieved from the abdominal cavity using an "endo-bag". Postoperatively, metronidazole with ciprofloxacin were started. The two-month follow-up in the outpatient setting did not reveal any complications in this group of patients.

Intraoperative bleeding was treated laparoscopically, which is consistent with the results reported by Tsushimi et al. (18). We were of the opinion that unanticipated bleeding should be the first indication for laparoscopic treatment (coagulation, clips) and should not be treated as a direct indication for conversion.

Currently, for acute cholecystitis surgery within 48-72 hours of pain onset is recommended (55-57) as the two-step treatment with deferred elective LCh is associated with higher rates of pericystic adhesions and fibrosis (55). Such management is widely used although there is no clear evidence (EBM) for the validity of early surgical treatment of ACh (the complication and conversion rates for gall-stone-induced ACh and CCh are similar) (35). The above recommendation results from the fact that in the first three days, which correspond to the oedema phase of ACh, effusion around the gall-bladder forms a space which facilitates GB resection (58). And the duration of inflammation is too short for pericystic adhesions to form (59). From day four (the gangrenous and phlegmonous phases), patients with ACh have a relative contraindication for urgent surgery due to hardness, thickening and contact bleeding at the GB wall affected by inflammatory infiltration. Given the above recommendations, our own experience in operating patients with long-lasting CCh and intraoperative technical difficulties which more frequently result in complications necessitating conversion to an open procedure (13, 22), we have introduced the rule to perform laparoscopic cholecystectomy for ACh within 48 hours of symptom onset. Exceptions to the rule include significant history of cardiological conditions, use of anticoagulants and no valid vaccination against hepatitis B.

CONCLUSIONS

Our results should be treated as predictors of intraoperative difficulties during laparoscopic cholecystectomy. The simple model of patient classification to an increased risk group using widely available ultrasound units facilitates the selection of an operative team, limits the risk of unnecessary conversions and improves operating room efficiency. Although such management scheme proves to be effective in diagnostic evaluation and treatment of the Olkusz county patients, it should be borne in mind that ultrasound assessment of the gall-bladder wall, even if no pathology has been found, remains an auxiliary examination and does not mean that the operator should not be watchful and thoughtful while skeletonising the Calot's triangle structures.

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