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The Role of Preoperative B-Mode and Doppler Ultrasonography in Predicting Technical Challenges for Laparoscopic Cholecystectomy

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Rezumat

Rolul ecografiei preoperatorii în modul B sau Doppler în predicția problemelor tehnice în colecistectomia laparoscopică

Scop: Scopul acestui studiu a fost de a prezice problemele tehnice probabile înainte de colecistectomia laparoscopică pentru a opera corespunzător pacientul, la momentul potrivit și cu tehnica corespunzătoare.
Metode: Studiul a fost efectuat într-un spital de referință terțiar pe o perioada de șase luni. Ecografiile în mod-B cu tonuri de gri, color, și *Doppler power* au fost practicate la cincizeci de pacienți consecutivi pentru care colecistectomia laparoscopică electivă a fost planificată. Dificultățile tehnice au fost notate de către un singur observator chirurg, în timp ce echipele au efectuat operațiiile. Nici observatororul și nici membrii echipei chirurgicale nu au cunoscut rezultatele testelor preoperatorii. Aceste două grupe de parametri au fost comparate.
Rezultate: Au fost corelații semnificative între problemele tehnice întâlnite în timpul operațiilor și măsurătorile preoperatorii ecografice: grosimea peretelui vezicii biliare, creșterea semnalului *power Doppler* a peretelui vezicii biliare, dimensiunea pietrei și vezica biliară plină cu pietre.
Concluzie: Ecografia în mod-B cu tonuri de gri și Ecografia Doppler sunt cele mai bune teste pentru estimarea problemelor intraoperatorii înainte de intervenția chirurgicală laparoscopică. Este important consensul între radiolog și chirurg.

Cuvinte cheie: colecistectomie laparoscopică, probleme tehnice, ecografie

Abstract

Purpose: The aim of this study was to predict probable technical challenges before laparoscopic cholecystectomy and to operate the proper patient at the right time and by the right technique.
Methods: The study was performed in a tertiary reference hospital in six months. B-mod grey scale, colour, and power Doppler ultrasonographies were obtained for fifty consecutive patients for whom elective laparoscopic holecystectomies were planned. The technical difficulties were noted by a single surgeon observer while the teams were performing the operations. Neither the observer nor the members of the surgical team were aware of the preoperative test results. These two groups of parameters were compared.
Results: There were significant correlations between the technical challenges encountered during the operations and preoperative ultrasonographic measurements: the mean of gallbladder wall thickness, increasing power Doppler signal

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of the gallbladder wall, stone size and the gallbladder's stone loading pattern.
Conclusion: B-mod grey scale and Doppler ultrasonography are the best tests at hand for predicting intraoperative challenges before laparoscopic surgery. It is important that the radiologist and surgeon reach consensus.

Key words: laparoscopic cholecystectomy, technical challenge, ultrasonography

Introduction

The timing is important in laparoscopic surgery for gallstones. Surgical complications can be avoided by delaying operation until after medical treatment for acute cholecytitis. In laparoscopic surgery, it is not always possible to determine the proper patient and the right time based on physical examination and biochemical parameters. Thus, radiological examination is very important. Ultrasonography (USG) is the most favourable technique for examination of the gallbladder and biliary tract and is routinely used during the preoperative period. However, correlations between preoperative USG and surgery are not well established, and the number of studies on the parameters affecting various stages of surgery has remained limited (1-9).

The aim of this study was to obtain objective correlations between the parameters in preoperative B-mode grey scale USG and Doppler USG and probable difficulties in laparoscopic surgery in performing the correct operation for proper patients at the right time.

Matherial and Method

The study involved 50 consecutive patients diagnosed with presence of gallstones, who were scheduled for elective laparoscopic cholecystectomy. The patients with gallstones were determined based on the findings of diagnostic abdominal USG. The patients had normal hepatic functions but no dilated intra or extra hepatic biliary tract or no leukocytosis in haematological tests. The physical examination revealed no acute cholecytitis findings in any of the patients. Patients who did not meet these criteria were excluded from the study.

The patients were operated in maximum 48 hours after repeated USG following 8 hours of fasting. The operation team was not informed about the above findings except first diagnostic USG. An observer, who was not a member of the operation team and was not informed about these findings, recorded the problems associated with the surgical technique. These findings were compared with the early preoperative USG results.

USG examinations of the liver, gallbladder, and biliary tract were performed using "Toshiba Power Vision 8000, SSA-390A" device with convex 3.5 MHz transducers. Examinations were done with the patients in supine, oblique decubitus, and erect positions with subcostal and intercostal visions.

Fifteen parameters were investigated by USG: 1) Count of the stones in the gallbladder, 2) Location of the stone/s, 3) Gallbladder stone loading pattern, 4) Gallbladder volume, 5) Gallbladder wall thickness, 6) Wall thickness pattern of the gallbladder 7) Stone size, 8) Mobility of the stone, 9) Adhesion of the gallbladder bed, 10) Dilatation of the ductus choledochus, 11) Absence or presence of a stone in the choledochus, 12) Colour Doppler signal of the gallbladder wall, 13) Power Doppler signal of the gallbladder wall, 14) Colour Doppler signal of the adjacent hepatic segment, 15) Power Doppler signal of the adjacent hepatic segment (*Table 1*).

The count of the stones in the gallbladder was classified as single or multiple. The location of the stone/s was defined as in the neck, corpus, or fundus. The fullness pattern of the gallbladder with stones was described as full/not full with millimetric/multiple stones or full/not full with a single stone. The volume of the gallbladder was calculated with the ellipsoid formula (0.52 x width x lenght x height). The patients were classified as those with gallbladder volume below or over 50 ml. For calculation of the wall thickness, 3 mm was accepted as the threshold value and measurements over this value were considered as thickening of the wall. The wall thickness pattern of the gallbladder was determined as regular or irregular. Stone size was calculated by measuring the maximum diameter of the biggest stone in the gallbladder. The mobility of the stone/s was/were evaluated with the patient in supine and lateral decubitus positions. In evaluating the adhesion of the gallbladder bed, the presence or absence of fixation of the fundus was examined based on different positions of the gallbladder. The largest diameter of the choledochus and probable stone condition in it were recorded. The blood supply of the gallbladder wall and adjacent liver segments were determined through colour and power Doppler USGs.

The observer evaluated the operative technique in five steps (1 - Entrance into peritoneal cavity and intraabdominal adhesions, 2 - Dissection of gallbladder adhesions, 3 - Dissection of Calot triangle, 4 - Dissection of gallbladder bed, 5 - Extraction of the gall bladder from the abdominal cavity) and scored difficulty as 0–1–2–3 for each patient (*Table 2*).

Statistical analysis

The data were analyzed with SPSS package program for Windows. Descriptive statistics were shown as patient numbers and percentages. The importance degrees of risk factors per surgical challenge were determined by Pearson Chi Square or Fisher's Exact Chi Square tests. The determinants with a significance value of $p < 0.25$ in univariate statistical analyses were considered potential risk factors and were presented to Multivariate Logistic Regression model. Risk factors that were the most predictive of the surgical difficulties were determined. The odds ratio and 95% confidence interval were calculated for each variable. $p < 0.05$ was considered statistically significant.

Table 1. *Parameters used on the preoperative ultrasonography and patient numbers*

Parameters		Patient Number
Count of the stones in the gallbladder	Single	21
	Multiple	29
Location of the stone/s	Neck	13
	Corpus	31
	Fundus	6
Gallbladder stone loading pattern	Gallbladder full with millimetric/multiple stones	9
	Gallbladder full with single stone	3
	Gallbladder not full with millimetric/multiple stones	20
	Gallbladder not full with single stone	18
Gallbladder volume	<50 ml	29
	≥ 50 ml	21
Gallbladder wall thickness	<3 mm	30
	≥ 3 mm	20
Wall thickness pattern of the gallbladder	Regular	45
	Irregular	5
Stone size	<2 cm	32
	≥ 2 cm	18
Mobility of the stone	Mobile	35
	Not mobile	15
Adhesion of the gallbladder bed	Adhesion absent	30
	Adhesion present	20
Dilatation of the ductus choledochus	<8 mm	50
	≥ 8 mm	0
Stone condition in the ductus choledochus	Absent	50
	Present	0
Colour Doppler signal of the gallbladder wall	Absent	41
	Present	9
Power Doppler signal of the gallbladder wall	Absent	30
	Present	20
Colour Doppler signal of the adjacent hepatic segment	Absent	44
	Present	6
Power Doppler signal of the adjacent hepatic segment	Absent	40
	Present	10

Results

The study involved 50 patients (37 female, 13 male; female /male ratio: 2.84). The median age was 49.3 years (range: 24–73). In two patients, because of difficulties during the dissection of the Calot triangle, the surgical procedure was changed from laparoscopic to open surgery. The parameters used in pre-operative USG examinations; values and patient numbers are shown in *Table 1*. The parameters for surgical difficulties, scoring system, and patient numbers according to these parameters are shown in *Table 2*. The distribution of the patients according to the factors affecting surgical difficulties are shown in *Table 3*, and p values, Odds ratios and 95% confidence intervals of these findings have been presented in *Table 4*:

1) There were no statistically significant correlations between entrance into peritoneal cavity /intraabdominal adhesions and preoperative USG parameters ($p>0.05$).
2) The correlation between the dissection of gallbladder adhesions and gallbladder wall thickness was statistically significant ($p<0.05$).
3) Although the dissection of Calot triangle (as an intaoperative parameter) and gallbladder wall thickness, and adhesion of gallbladder bed (as preoperative USG parameters ($p=0.057$ for both) were correlated, the correlation was not statistically significant.
4) Operative difficulty in gallbladder bed dissection and preoperative gallbladder wall thickness and power Doppler signal of gallbladder wall ($p<0.005$ for both) were statistically significantly correlated.
5) When we compared the extraction of the gallbladder from the abdominal cavity as an intraoperative parameter with stone size and loading pattern of the gallbladder with stones, the correlations were statistically significant ($p<0.05$ for both).

In multivariate analysis, only gallbladder wall thickness $>$ 3 mm showed statistically significant effects on dissection difficulty of the gallbladder adhesions ($p=0.028$; Odds Ratio=13.568 and Confidence Interval 95%=1.321 – 139.382). Moreover, only the gallbladder wall thickness $>$ 3 mm had statistically significant effects on dissection difficulty of the gallbladder bed ($p= 0.018$; Odds Ratio=17.033 and Confidence Interval 95%= 1.614 – 179.742). Extraction of the gallbladder; complete fullness ($p=0.011$; Odds Ratio=14.050

Table 2. *The distribution of the numbers of patients according to the parameters for surgical difficulties*

Parameters		Patient number
Entrance difficulty into peritoneal cavity and intraabdominal adhesions	0)No adhesion	31
	1)Adhesion near the gallbladder	6
	2)Adhesion near the liver and gallbladder	8
	3)Adhesion in whole abdomen	5
Difficulty in dissection of the adhesions to gallbladder adhesions	0)No adhesion	12
	1)Adhesion on less than 1/3 of gallbladder	14
	2)Adhesion on 1/3-2/3 of gallbladder	12
	3)Adhesion on more than 2/3 of gallbladder	12
Difficulty in dissection of Calot triangle	0)Calot is completely free	10
	1)Minimum thickness in Calot	17
	2)Calot is completely thick and LAP is present	16
	3)Calot can't be seen and choledochus can't be dissected	7
Difficulty in dissection of the gallbladder bed	0)Gallbladder is bared spontaneously	13
	1)Gallbladder adheres peritoneum, but dissection is easy	18
	2)Gallbladder adheres to bed and dissection is difficult	14
	3)Gallbladder is embedded	5
Difficult y in extraction of the gallbladder from the abdominal cavity	0)Gallbladder exits spontaneously	23
	1)Gallbladder exits with manipulation	12
	2)Necessity to empty the gallbladder	6
	3)Impacted stone in the incision and necessity to extend the incision	9

Table 3. *The distribution of patients according to factors affecting surgical difficulties*

VARIABLES	DEPC		DDGA		DDCT		DDGB		DPGA	
	No (n=31)	Yes (n=19)	No (n=12)	Yes (n=38)	No (n=10)	Yes (n=40)	No (n=13)	Yes (n=37)	No (n=23)	Yes (n=27)
Multiple stones	16 (51.6%)	13 (68.4%)	5 (41.7%)	24 (63.2%)	5 (50.0%)	24 (60.0%)	5 (38.5%)	24 (64. 9%)	13 (56.5%)	16 (59.3%)
Location of stones										
Neck	7 (22.6%)	6 (31.6%)	3 (25.0%)	10 (26.3%)	4 (40.0%)	9 (22.5%)	4 (30.8%)	9 (24.3%)	6 (26. 1%)	7 (25.9%)
Corpus	21 (67.7%)	10 (52.6%)	9 (75.0%)	22 (57.9%)	6 (60.0%)	25 (62.5%)	9 (69.2%)	22 (59.5%)	16 (69.6%)	15 (55.6%)
Fundus	3 (9.7%)	3 (15.8%)	0 (0%)	6 (15.8%)	0 (0.0%)	6 (15.0%)	0 (0.0%)	6 (16.2%)	1 (4.3%)	5 (18.5%)
Complete fullness	8 (25.8%)	4 (21.1%)	1 (8.3%)	11 (28.9%)	0 (0.0%)	12 (30.0%)	1 (7.7%)	11 (29.7%)	2 (8.7%)	10 (37.0%)
Volume >50 ml	11 (35.5%)	10 (52.6%)	3 (25.0%)	18 (47.4%)	3 (30.0%)	18 (45.0%)	5 (38.5%)	16 (43.2%)	7 (30.4%)	14 (51.9%)
Wall thickness >3 mm	10 (32.3%)	10 (52.6%)	1 (8.3%)	19 (50.0%)	1 (10.0%)	19 (47.5%)	1 (7.7%)	19 (51.4%)	7 (30.4%)	13 (48.1%)
Irregular wall thickness	2 (6.5%)	3 (15.8%)	0 (0.0%)	5 (13.2%)	0 (0.0%)	5 (12.5%)	1 (7.7%)	4 (10.8%)	1 (4.3. %)	4 (14.8%)
Stone size >2 cm	9 (29.0%)	9 (47.4%)	3 (25.0%)	15 (39.5%)	1 (10.0%)	17 (42.5%)	4 (30.8%)	14 (37.8%)	3 (13.0%)	15 (55.6%)
Immobile stone	7 (22.6%)	8 (42.1%)	3 (25.0%)	12 (31.6%)	1 (10.0%)	14 (35.0%)	3 (23.1%)	12 (32.4%)	7 (30.4%)	8 (29.6%)
Adhesion of the gallbladder bed	11 (35.5%)	9 (47.4%)	3 (25.0%)	17 (44.7%)	1 (10.0%)	19 (47.5%)	4 (30.8%)	16 (43.2%)	9 (39.1%)	11 (40.7%)
Colour Doppler signal of gallbladder wall	5 (16.1%)	4 (21.1%)	2 (16.7%)	7 (18.4%)	2 (20.0%)	7 (17.5%)	2 (15.4%)	7 (18.9%)	3 (13.0%)	6 (22.2%)
Power Doppler signal of gallbladder wall	11 (35.5%)	9 (47.4%)	2 (16.7%)	18 (47.4%)	2 (20.0%)	18 (45.0%)	2 (15.4%)	18 (48.6%)	8 (34.8%)	12 (44.4%)
Colour Doppler signal of adjacent hepatic segment	3 (9.7%)	3 (15.8%)	1 (8.3%)	5 (13.2%)	1 (10.0%)	5 (12.5%)	1 (7.7%)	5 (13.5%)	2 (8.7%)	4 (14.8%)
Power Doppler signal of adjacent hepatic segment	5 (16.1%)	5 (26.3%)	2 (16.7%)	8 (21.1%)	2 (20.0%)	8 (20.0%)	2 (15.4%)	8 (21.6%)	3 (13.0%)	7 (25.9%)

DEPC: Difficulty in entrance into the peritoneal cavity, DDGA: Difficulty in dissection of the gallbladder adhesions, DDCT: Difficulty in dissection of Calot triangle, DDGB: Difficulty in dissection of the gallbladder bed, DPGA: Difficulty in pulling out the gallbladder from the abdomen.
a: Reference category

Table 4. *p values, Odds ratios and 95% confidence intervals of the factors affecting surgical difficulties*

Variables	DEPC	DDGA	DDCT	DDGB	DPGA
	p Value / Odds Ratio (95% Confidence Interval)				
Multiple stones	0.242 / 2.031 (0.614-6.721)	0.189 / 2.400 (0.639-9.015)	0.723 / 1.500 (0.373-6.032)	0.097 / 2.954 (0.801-10.897)	0.845 / 1.119 (0.363-3.452)
Location of stones					
Neck	1.000a	1.000a	1.000a	1.000a	1.000a
Corpus	0.385 / 0.556 (0.148-2.090)	0.686 / 0.733 (0.163-3.304)	0.413 / 1.852 (0.423-8.110)	0.908 / 1.086 (0.265-4.451)	0.741 / 0.804 (0.219-2.943)
Fundus	0.876 / 1.167 (0.168-8.090)	-	-	-	0.236 / 4.286 (0.386-47.625)
Complete fullness	1.000 / 0.767 (0.196-3.003)	0.248/ 4.481 (0.515-39.009)	-	0.147 / 5.077 (0.586-43.951)	**0.019 / 6.176 (1.189-32.076)**
Volume > 50 ml	0.233 / 2.020 (0.631-6.463)	0.171 / 2.700 (0.631-11.551)	0.488 / 1.909 (0.431-8.463)	0.764 / 1.219 (0.335-4.441)	0.126 / 2.462 (0.767-7.897)
Wall thickness > 3 mm	0.153 / 2.333 (0.721-7.547)	**0.016 / 11.000 (1.290-93.832)**	0.057 / 8.143 (0.942-70.409)	**0.006 / 12.667 (1.491-107.599)**	0.203 / 2.122 (0.662-6.809)
Irregular wall thickness	0.355 / 2.719 (0.411-18.004)	-	-	1.000 / 1.455 (0.147-14.346)	0.357 / 3.826 (0.396-36.957)
Stone size > 2 cm	0.190 / 2.200 (0.670-7.220)	0.497 / 1.957 (0.455-8.421)	0.073 / 6.652 (0.768-57.624)	0.746 / 1.370 (0.354-5.295)	**0.002 / 8.333 (1.992-34.870)**
Immobile stone	0.144 / 2.494 (0.721-8.619)	1.000 / 1.385 (0.317-6.051)	0.246 / 4.846 (0.556-42.264)	0.728 / 1.600 (0.371-6.906)	0.951 / 0.962 (0.286-3.237)
Adhesion of the gallbladder bed	0.405 / 1.636 (0.512-5.235)	0.317 / 2.429 (0.567-10.402)	0.057 / 8.143 (0.942-70.409)	0.430 / 1.714 (0.446-6.583)	0.908 / 1.069 (0.343-3.331)
Colour Doppler signal of the gallbladder wall	0.715 / 1.387 (0.322-5.973)	1.000 / 1.129 (0.201-6.340)	1.000 / 0.848 (0.147-4.888)	1.00 / 1.283 (0.231-7.143)	0.479 / 1.905 (0.419-8.667)
Power Doppler signal of the gallbladder wall	0.405 / 1.636 (0.512-5.235)	0.091 / 4.500 (0.867-23.345)	0.279 / 3.273 (0.616-17.385)	**0.035 / 5.211 (1.012-26.828)**	0.487 / 1.500 (0.477-4.717)
Colour Doppler signal of adjacent hepatic segment	0.661 / 1.750 (0.315-9.716)	1.000 / 1.667 (0.175-15.858)	1.000 / 1.286 (0.133-12.427)	1.000 / 1.875 (0.198-17.740)	0.674 / 1.826 (0.303-11.020)
Power Doppler signal of adjacent hepatic segment	0.474 / 1.857 (0.458-7.528)	1.000 / 1.333 (0.242-7.348)	1.000 / 1.000 (0.177-5.654)	1.000 / 1.517 (0.278-8.287)	0.308 / 2.333 (0.527-10.330)

DEPC: Difficulty in entrance into the peritoneal cavity, DDGA: Difficulty in dissection of adhesions of gallbladder, .CT: Difficulty in dissection of Calot triangle, DDGB: Difficulty in dissection of the gallbladder bed, DPGA: Difficulty in pulling out the gallbladder from the abdomen. a: Reference category

Table 5. *The factors affecting surgical difficulties (multivariate logistic regression analysis)*

Dependent Variables	Independent Variables	Odds Ratio	p-Value	95 % Confidence Interval	
				Lower Limit	Upper Limit
DDGA	Multiple Stone	2.928	0.189	0.590	14.537
	Complete Fullness	6.329	0.121	0.616	65.070
	Volume > 50ml	2.922	0.237	0.495	17.257
	Wall Thickness > 3 mm	1.568	0.028	1.321	139.382
	GWPD	1.690	0.603	0.234	12.210
DDGB	Multiple Stone	4.099	0.090	0.801	20.979
	Complete Fullness	7.155	0.105	0.665	77.040
	Wall Thickness > 3 mm	17.033	0.018	1.614	179.742
	GWPD	3.413	0.220	0.479	24.306
DPGA	Complete Fullness	14.050	0.010	1.896	104.116
	Volume > 50 ml	3.082	0.143	0.684	13.879
	Wall Thickness > 3 mm	1.940	0.375	0.449	8.386
	Stone Size > 2 cm	7.914	0.011	1.603	39.065

DDGA: Difficulty in dissection of the gallbladder adhesions, DDGB: Difficulty in dissection of the gallbladder bed, DPGA: Difficulty in pulling out the gallbladder from the abdomen, GWPD: Gallbladder wall - power Doppler signal

and Confidence Interval 95%=1.896 – 104.116) and stone size > 2 cm (p=0.011; Odds Ratio= 7.914 and Confidence Interval 95%=1.603 – 39.065) also had statistically significant effects (*Table 5*).

Discussions

Ultrasonography is used in the diagnosis of gallbladder and biliary tract diseases. It is also a highly accurate guide for

determining the proper surgical technique according to certain parameters in the preoperative period. The aim of our study was to obtain objective correlations between the parameters determined by preoperative B-mod grey scale and Doppler USG and the difficulties described for laparoscopic surgery. Some of our results were similar to those in the medical literature, whereas others were different and/or novel.

In our study, it was determined that the gallbladder volume was not a parameter to determine surgical difficulty, as it was in previous studies (1,2). Generally, it is accepted that values over 50 ml are predictive for surgical challenge, and this parameter is used in various scoring systems (3,4,5,6,7,8).

There were statistically significant correlations between the gallbladder wall thickness and the dissection of the gallbladder adhesions and dissection of gallbladder bed (p and OR values were 0.016 - 11.000 and 0.006 - 12.667 respectively). There was no statistically significant correlation between the gallbladder wall thickness and the dissection of Calot triangle, but the p value was 0.057 and OR was 8.143. However, a larger sample size may change the results. Inflammation in acute and /or chronic cholecytitis increases the thickness of the gallbladder wall and its fragility, and leads to adhesions of the adjacent tissues and organs, thus rendering the surgical process difficult. Several studies have used wall thickness as the main parameter (2–5, 8–22). As in these studies, we used 3 mm threshold value to evaluate wall thickness and classified patients as those with less than 3 mm wall thickness, and with 3 mm or higher than 3 mm wall thickness. Chen et al have also provided a detailed classification of wall thickness in their study where wall thickness was evaluated as a single parameter (22). Likewise, Majeski used wall thickness alone in the preoperative USG measurements (10). Wall thickness was reported to be the primary reason for conversion from laparoscopic technique to open in some studies (9,11,13–15,18–22). Ammori et al emphasized that the higher the wall thickness was, the longer the operation time was (16). In the study by Corr et al, the degree of operative difficulty increased with increased wall thickness, but this was not observed with increased gallbladder volume or the count of gall stones (2). We found no statistically significant correlations between wall thickness and the parameters of entrance into the peritoneal cavity and intraabdominal adhesions, or pulling out the gallbladder from the peritoneal cavity.

In our study, no statistically significant correlations were determined between the parameter of loading pattern of the gallbladder with stones and the parameters of surgical difficulty. This finding is was similar to the findings of the study by Cho et al (5).

In previous studies, there were no correlations between stone size and surgical difficulties. In these studies, when used as a parameter, the largest stone size was taken into consideration rather than the mean stone size. The threshold value was accepted as 2 cm and the values below and over this were compared (3-5,20,23). Costi et al investigated the values of 300 patients. They categorized patients as having 5 mm and smaller stone size (positive stone group) and having single stone (negative stone group), and established the risk of asymptomatic choledochus calculi based on this classification (24). We also used the threshold value of 2 cm for the largest stone while using the stone size as a parameter. In the evaluation of the parameters for operative difficulty, only the correlation between the preoperative stone size as measured on USG and pulling out the gallbladder from the peritoneal cavity was statistically significant (p=0.002 and OR= 8.333). On the other hand, at the time of dissection of the gallbladder adhesions and dissection of Calot triangle, we observed that manipulation of the gallbladder neck was difficult particularly when the stone(s) impacted the neck. Although when the stone size threshold was taken as 2 cm, no significant correlations were observed, this result may be different with a larger series of patients.

No statistically significant correlations were determined between the preoperative stone size and operative parameters. On the other hand, especially the immobile stone(s) in the gallbladder neck probably makes it difficult to manipulate the organ. It was thought that immobilization of the stone was a secondary process to the current inflammatory process of the gallbladder (8). Velden et al found parallel results, while the results of the study by Cho et al were contrary to our findings (7,5).

In our study, the degree of adhesion in the gallbladder bed as a USG parameter and difficulty in dissecting Calot triangle were not significantly correlated (p=0.057 and OR=8.143). As with the parameter of wall thickness, however, the correlation may be significant if studied in a larger series. In our patients with gallbladder bed adhesions, the Calot triangle was thicker and more fixed (5,7,8,17), which is compatible with the findings of earlier studies. Any statistically significant correlations between these parameters may be considered novel, but it should similarly be confirmed by studies with larger series. In our study, however, the degree of adhesion of the gallbladder bed and other operative difficulty parameters were not correlated.

When we compared power Doppler signal of the gallbladder wall and difficulty of dissection of the gallbladder bed, the correlation was statistically significant (p=0.035 and OR=5.211). In addition, although there was a weak correlation between the difficulty in dissection of the adhesions to the gallbladder (p=0.091 and OR=4.500), there were no correlations between colour Doppler signal of the gallbladder and any of the surgical parameters. This is probably due to the higher sensitivity of power Doppler system in visualization of the vascular flow than that of colour Doppler system. Besides, power Doppler is known to be more sensitive in the examination of the organs with slow vascular flow. Nevertheless, power Doppler does not provide sufficient information on flow direction and/or flow rate (25-27).

In our study, no statistically significant correlations were found between the parameters of the colour or power Doppler signals of the adjacent hepatic structures and the surgical difficulty parameters. These findings are parallel to the findings of previous studies (5). On the other hand, preoperative Doppler ultrasonography evaluations show potential risks of haemorrhage secondary to middle hepatic vein injury (28,29).

There were no correlations between the number and location of the stones in the gallbladder and the surgical difficulty parameters. Particularly the stones located and impacted in the gallbladder neck might affect the surgical technique negatively. Some studies emphasized that the number of stones was not a risk factor to convert from laparoscopic operation to open technique (20,23), while others have reported the opposite (9). In these studies, when the stone size and number were scored together, it yielded results that were predictive of a need for intraoperative cholangiography (6,24).

In our study, there was statistically significant correlation between the USG parameter of fullness pattern of the gallbladder with stones and pulling out the gallbladder from the peritoneal cavity ($p=0.019$ and $OR=6.176$), whereas there were no correlations between the other four parameters.

In conclusion, early preoperative USG and Doppler USG before laparoscopic cholecystectomy are currently the best techniques in predicting probable intraoperative difficulties and conversion rates. Every effort should be made to allot the proper patient to the proper technique and choose the timing of surgery wisely in gallbladder surgery.

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