

**CLASSIFICATION OF DIFFICULT LAPAROSCOPIC CHOLECYSTECTOMY
BASED ON IDENTIFICATION, DISSECTION AND PROCEDURAL (IDP)
PROBLEMS' SOLUTION**

Abstract

Aim: The aim of this research is to present the classification of difficult laparoscopic cholecystectomy based on additional procedures necessary for resolving intraoperative problems.

Material and methods. Laparoscopic cholecystectomy (LC) has four complexity levels under the classification based on the nature of additional procedures for solving identification, dissection and procedural (IDP) issues caused by pathological changes around the gallbladder and intraoperative complications: first level without identification, dissection and procedural (IDP) issues and managed by standard procedures, second level with the IDP problems solved by simple additional procedures, third level with problems solved by additional procedures which has complication risk, and fourth level requiring additional or alternative surgery. In this classification, the complexity levels can be determined by grading (on the basis of the "hardest" additional procedure applied in any stage of surgery) and points system (additional procedures carried out in each stage are assessed by points and the complexity level is determined by the sum of these points: points 0-2 - first level, points 3-8 – second level, points 9-15 – third level, points more than 16 – fourth level).

Results. This classification has been applied in 1695 patients who have undergone laparoscopic cholecystectomy for acute and chronic gallstone disease and gallbladder polyps: laparoscopic cholecystectomy of first level has been conducted in 44% of patients, second level – in 35.9%, third level – in 14.9% and fourth level – in 4.9%. In vast majority of patients (79.9%), laparoscopic cholecystectomy was completed with standard or simple procedures. In total, 3894 additional procedures were carried out, 3043 (78,1%) of which included simple procedures, 658 (16.8%) - risky procedures, and 193 (4.9%) - additional surgeries.

Conclusion. To determine the difficulty of laparoscopic cholecystectomy, four-level problem- resolving-based classification may be used which based on the nature of additional procedures to eliminate the identification, dissection and procedural (IDP) problems or complications during the surgery.

Key words: difficult laparoscopic cholecystectomy, intraoperative IDP problems, grading, classification

Introduction

Laparoscopic cholecystectomy (LC) is currently recognized as the "gold standard" of surgical treatment of both chronic and acute diseases of the gallbladder and is one of the most frequently performed surgical operations today [1]. In the history of this operation, which became widespread at the end of the last century, two stages of development can be noted. In the initial stage, covering about the 90s, this operation, considered as an alternative approach to open cholecystectomy, was mainly recommended for non-acute diseases of the gallbladder (chronic cholecystitis, gallbladder polyp, dyskinesia); for acute cholecystitis, previous abdominal surgeries, lung problems, liver cirrhosis and other risky cases was considered as

relative or absolute contraindication ("LC - in chronic diseases, open cholecystectomy – in risky cases") [2]. However, the accumulation of experience and technical development (instruments, image quality, intraoperative diagnostics and etc.) have seriously reduced contraindications to LC, and this operation has become the method of choice in all cases where cholecystectomy is indicated. Most of the technical aspects of this operation were also standardized at this stage: intra-abdominal pressure of 8-14 mm Hg, wide dissection of the Calot area and the proximal 1/3 of the gallbladder, the formation of "two windows" after dissection of the cystic duct and cystic artery and etc. [3, 4]. However, in addition to all this, obesity, elderly age, adhesions around the gallbladder, inflammatory-destructive processes in the gallbladder, inflammatory-fibrotic changes in the liver and hilum of the liver, morphological changes in the ducts and vessels, concomitant diseases, and other factors revealed various variants of LC [5, 6]. In this regard, in order to assess the activities of surgeons and hospitals, to analyze the medical, social and economic consequences of the operation, the problem of the complexity of the LC was raised. Unfortunately, currently there is no standard criterion for determining the complexity of LC. Most of the known classifications gave priority to preoperative prediction of complications, and one study classified according to several intraoperative parameters (pathological changes in and around the gallbladder, duration of operation [7, 8, 9, 10]. In this article, we present a LC classification based on IDP problems' solution.

Aim

The aim of this research is to present the classification of difficult laparoscopic cholecystectomy based on additional procedures necessary for resolving intraoperative problems.

Material and methods

The study included the results of 1995 patients who underwent LX between 2006 and 2022. The operations were performed at the Central Clinic Hospital, the Central Customs Hospital, the Scientific Center of Surgery named after Topchubashov and Surgical Clinic of Azerbaijan Medical University. The age range of patients ranged from 14 to 91 years, 1374 women and 621 men. Indications for surgery were chronic calculous cholecystitis (1381), acute calculous cholecystitis (531), gallbladder polyp (83). Our standard approach for acute calculous cholecystitis is to perform LC within the first 12-24 hours. In patients with choledocholithiasis, one-stage LC and choledocholithotomy were used as the first choice. The LC was performed with the standard 4 ports.

Classification methodology (basics, philosophy). The proposed classification is based on the following 3 principles:

1. Problems caused by changes in the gallbladder or around it, as well as complications during surgery are taken into account. Any operation can be represented as the sum of three processes, including IDP. Changes in or around the gallbladder can cause various problems in one or more of these processes that may require additional intervention.
2. The problems that arise at each technical stage of the operation are taken into account (entry into the abdominal cavity, suspension of the gallbladder and liver, Calot dissection, dissection of the cystic duct and cystic artery, stages of separation from the liver bed and removal from the abdominal cavity).
3. Based on additional interventions used to solve problems and complications during IDP, as well as their gradation. When evaluating additional interventions, the nature of additional technical means, the possibility of complications of the operation and additional surgery are taken into account. Therefore, additional

interventions can be divided into long-term interventions performed by standard technique, interventions with a high probability of complications, and additional operations. For example, peritoneal and organ adhesions around the gallbladder, large and hard liver, edema around the gallbladder, exudation and bleeding during dissection, bloating, obesity, and other factors that can make it difficult to identify the gallbladder, duct and vessels. To solve these problems, simple procedures with little chance of complications are needed, such as positioning, an additional retractor to elevate the liver, continuous aspiration for bleeding, dissection with cauterization to separate adhesions. However, dissection performed to solve problems in identifying fibrous adhesions around the gallbladder, in the Calot area, and in the gallbladder bed may increase organ damage. Even with bleeding due to portal hypertension (PH) and induration of the hepatoduodenal ligament, the difficulty of identification may be such that it is impossible to complete the operation; while alternative operations are performed, such as cholecystostomy and partial cholecystectomy. Mirizzi syndrome may require additional surgery, such as a choledochal drainage or anastomosis, because the standard surgery (closure of the cystic duct) cannot be performed. Among the complications arising from surgical intervention, the most common are bleeding or organ damage, which are divided into 2 groups depending on the method of their elimination: those that can be eliminated by simple methods (bleeding stopped by cauterization or suturing), and those that require additional operations (vascular, ductal anastomoses, etc.)

Thus, in accordance with the classification based on the technique of additional interventions necessary to eliminate the problems of IDP caused by changes in the gallbladder and around it, and complications that occur during surgery, there are 4 grades of intraoperative complications of LC.

- I grade or easy LC - no changes in the gallbladder and around it, no problems with IDP at the stages of the operation, no intraoperative complications, the operation is performed in a standard way;
- II grade or slightly difficult LC – identification, dissection or complications caused by changes in and around the gallbladder are treated with simple but time-consuming procedures. For example, an additional retractor to lift a large or cirrhotic liver, cauterization to separate abdominal adhesions, puncture and use of large forceps to grasp and lift a tense gallbladder, dissection of the edematous zone of Calot, closure of the large cystic duct, cauterization to stop bleeding from the bed, etc.
- III grade or complex LC – operations with a high risk of complications or requiring additional technical means used to eliminate problems of IDP caused by changes in and around the gallbladder, or complications arising during the operation. For example, a scar in the abdominal wall, separation of fibrous adhesions around the gallbladder and in the Calot area, intraoperative cholangiography to identify the bile ducts, etc.
- IV grade or very complicated LC – additional or alternative surgery is required to solve problems with IDP caused by changes in and around the gallbladder. For example, cystic fistulas, Mirizzi syndrome, resection of the gallbladder bed, partial cholecystectomy for bleeding in liver cirrhosis, anastomoses for damaged intestines, choledochus and large vessels, etc.

Complexity assessment methods. To determine the degree of difficulty in this classification, two methods can be used: gradation and a score system. To determine the degree of complexity by the gradation, the most "severe" additional interventions used at any

stage of the LC are noted (Table 1).

Table 1. Grading table for determining the degree of complexity of LC.

Grading	I grade	II grade	III grade	IV grade
	Standard operations	Simple additional interventions	Surgery can cause complications	Additional or alternative surgery required
Points	0-2	3-8	9-15	More than 16
Access to the abdominal cavity	Standard umbilical access (puncture or open)		Non-standard (hernia, scar, marginal access, obesity)	
Lifting the gallbladder and liver	Capturing the gallbladder and lifting the liver is performed in the standard way	Additional interventions are required to capture the gallbladder and lift the liver: puncture, large clamp, retractor or other interventions (tense, thick-walled gallbladder, necrosis, cirrhosis, large liver, obesity, pericholecystic infiltration, bloating, etc.)		
Separation of the anterior wall of the gallbladder	There are no adhesions around the gallbladder, it separates freely	Simple peritoneal adhesions are noted, dissection is not difficult, but takes time. Around the gallbladder, fibrous peritoneal adhesions, dissection with bleeding, constant aspiration or resection of the omentum is	There are fibrous adhesions with organs, possible damage of organs during dissection	There is a fistula between the gallbladder and another organ, it is necessary to suture the fistula

		required. There is a perivesicular abscess (sanation is necessary).		
Calot area dissection	Identification and dissection are standard	Fatty or edematous, prolongs dissection time	Fibrous, but identifiable and detachable (possible injury on detachment). Fibrous, identified with the help of additional interventions (intraoperative cholangiography, US, injection of a contrast agent, fundus-down cholecystectomy, etc.)	Fibrous, not identified, dissection is dangerous, alternative treatment is used: cholecystostomy, partial cholecystectomy, drainage, laparotomy, etc. There are collaterals, therefore dissection with bleeding (from collaterals in liver cirrhosis and portal vein thrombosis).
Dissection of cystic artery and cystic duct	Standard (clips)	Ligation or suturing	There is an abnormality of the cystic artery and cystic duct (possibly damage requiring cholangiography)	Mirizzi syndrome type 1 or 2 (additional procedures are required, such as cholangiography and drainage of the choledochus, etc.). Destruction in the area of junction of the cystic duct and choledochus (an additional operation is required: drainage of the choledochus).
Separation of the gallbladder from the bed	Bed without adhesions, standard dissection is carried out	Edematous or mesentery present (bleeding or exudate on dissection, continuous aspiration required). There are Luschka's duct (clipping is required). There is necrosis and	There are fibrous adhesions that are easily detached (possible liver damage)	There are fibrous adhesions that do not separate, liver resection is performed. The dissection is bleeding, cannot be continued, and alternative surgery (partial cholecystectomy or cholecystostomy)

		abscess in the bed (necrectomy is necessary).		may be chosen. Gallbladder located intrahepatic (requires hepatotomy).
Removal of the gallbladder	Standard	Removal by widening the incision. Removal of parts of the gallbladder piece by piece		
Complications	None	Bleeding - stopped by cauterization or suturing		<p><i>Due to illness</i> Diffuse bile peritonitis (sanation and drainage of the peritoneum). Choledocholithiasis, cholangitis (drainage of choledoch, removal of stones from choledoch). Pancreatitis (peripancreatic drainage, etc.)</p> <p><i>Due to surgery</i> Organ damage – require suturing. Vascular injuries – requiring suturing of vessels (pulmonary artery, portal vein, etc.) Organ injuries – requiring reconstruction (bile ducts, etc.)</p>

When assessed by a scoring system, additional interventions performed at each stage are evaluated by a score and the severity is determined by the sum of the points: 0-2 points is I grade, 3-8 points is II grade, 9-15 points is III grade, and more than 16 points is IV grade (Table 2).

Table 2. Score table for determining the degree of complexity of LC.

	Points
Access to the abdominal cavity	
Standard umbilical access (puncture or open)	0

Non-standard (hernia, scar, marginal access, obesity)	5
Lifting the gallbladder and liver	
Capturing the gallbladder and lifting the liver is performed in the standard way	0
Additional interventions are required to capture the gallbladder and lift the liver: puncture, large clamp, retractor or other interventions (tense, thick-walled gallbladder, necrosis, cirrhosis, large liver, obesity, pericholecystic infiltration, bloating, etc.)	1
Separation of the anterior wall of the gallbladder	
There are no adhesions around the gallbladder, it separates freely	0
Simple peritoneal adhesions are noted, dissection is not difficult, but takes time.	1
Around the gallbladder, fibrous peritoneal adhesions, dissection with bleeding, constant aspiration or resection of the omentum is required.	1
There is a perivesicular abscess (sanation is necessary)	1
There are fibrous adhesions with organs, possible damage of organs during dissection	5
There is a fistula between the gallbladder and another organ, it is necessary to suture the fistula	10
Calot area dissection	
Identification and dissection are standard	0
Fatty or edematous, prolongs dissection time	1
Fibrous, but identifiable and detachable (possible injury on detachment).	5
Fibrous, identified with the help of additional interventions (intraoperative cholangiography, US, injection of a contrast agent, fundus-down cholecystectomy, etc.)	5
Fibrous, not identified, dissection is dangerous, alternative treatment is used: cholecystostomy, partial cholecystectomy, drainage, laparotomy, etc.	10
There are collaterals, therefore dissection with bleeding (from collaterals in liver cirrhosis and portal vein thrombosis)	10
Dissection of cystic artery and cystic duct	
Standard (clips)	0
Ligation or suturing	1
There is an abnormality of the cystic artery and cystic duct (possibly damage requiring cholangiography)	5
Mirizzi syndrome type 1 or 2 (additional procedures are required, such as cholangiography and drainage of the choledochus, etc.)	10
Destruction in the area of junction of the cystic duct and choledochus (an additional operation is required: drainage of the choledochus)	10
Separation of the gallbladder from the bed	
Bed without adhesions, standard dissection is carried out	0
Edematous or mesentery present (bleeding or exudate on dissection, continuous aspiration required)	1
There are Luschka's duct (clipping is required)	1
There is necrosis and abscess in the bed (necrectomy is necessary)	1
There are fibrous adhesions that are easily detached (possible liver damage)	5
There are fibrous adhesions that do not separate, liver resection is performed	10
The dissection is bleeding, cannot be continued, and alternative surgery (partial cholecystectomy or cholecystostomy) may be chosen	10
Gallbladder located intrahepatic (requires hepatotomy)	10
Removal of the gallbladder	

Standard	0
Removal by widening the incision	1
Removal of parts of the gallbladder piece by piece	1
Complications	
None	0
Due to illness	
Diffuse bile peritonitis (sanation and drainage of the peritoneum)	10
Choledocholithiasis, cholangitis (drainage of choledoch, removal of stones from choledoch)	10
Pancreatitis (peripancreatic drainage, etc.)	10
Due to surgery	
Bleeding - stopped by cauterization	1
Bleeding - stopped by suturing	1
Organ damage – require suturing	10
Vascular injuries – requiring suturing of vessels (pulmonary artery, portal vein, etc.)	15
Organ injuries – requiring reconstruction (bile ducts, etc.)	15
Other	

Results

According to the presented classification, in 1995 patients, in 44% of patients was performed LC of the I grade, in 35.9% – the II grade, in 14.9% – the III grade and in 4.9% – the IV grade (Table 3). The vast majority of patients (79.9%) underwent standard LC or LC with simple additional interventions.

A total of 3894 additional interventions were performed, 3043 (78.1%) of them were simple interventions, 658 (16.8%) – risky interventions and 193 (4.9%) – additional operations. Among simple additional interventions, the most frequently performed were separation of peritoneal adhesions on the anterior wall of the gallbladder (572), dissection of the fat or edematous Calot area (549), additional interventions to elevate the gallbladder and liver (455). Among the risky interventions, the main place was occupied by the separation of fibrous adhesions around the gallbladder (507). Additional interventions for choledocholithiasis (65), pancreatitis (36), bleeding (24) and fibrous adhesions (19) were the most common reasons for additional or alternative surgeries such as biliary drainage (98) and partial cholecystectomy (31).

Problems were most often encountered during separation of the anterior wall of the gallbladder (926), Calot area (840) and separation from the bed (813). Simple additional interventions have been most commonly used in separation of the anterior wall of the gallbladder (711), dissection of the Calot area (640) and elevation of the gallbladder (455). Risky interventions were mainly carried out in the process of separation of the anterior wall (208) and dissection of the Calot area (177). Additional operations were performed mainly in connection with the elimination of complications (111), due to problems in the identification of the Calot area (23) and separation of the gallbladder from the bed (23). Intraoperative complications were detected in 75 patients (4.4%), among which the majority (86.6%) were bleeding; vascular and organ damage was detected in 10 patients (intestinal damage – 6, hepatic artery damage – 2, choledoch – 2). The conversion was performed in 3 patients (bleeding – 1, damage to the common bile duct – 1, damage to the intestines – 1).

Table 3. Distribution of patients according to the grade of complexity of LC.

	Points	Sum	I	II	III	IV
Access to the abdominal cavity						
Standard umbilical access (puncture or open)	0	1851	947	622	203	79
Non-standard (hernia, scar, marginal access, obesity)	5	144		55	72	17
Lifting the gallbladder and liver						
Capturing the gallbladder and lifting the liver is performed in the standard way	0	1490	890	490	76	34
Additional interventions are required to capture the gallbladder and lift the liver: puncture, large clamp, retractor or other interventions (tense, thick-walled gallbladder, necrosis, cirrhosis, large liver, obesity, pericholecystic infiltration, bloating, etc.)	1	505		255	194	56
Separation of the anterior wall of the gallbladder						
There are no adhesions around the gallbladder, it separates freely	0	909	720	5	41	3
Simple peritoneal adhesions are noted, dissection is not difficult, but takes time.	1	490	27	371	4	9
Around the gallbladder, fibrous peritoneal adhesions, dissection with bleeding, constant aspiration or resection of the omentum is required.	1	295		201	27	16
There is a perivesicular abscess (sanation is necessary)	1	81		31	14	11
There are fibrous adhesions with organs, possible damage of organs during dissection	5	213		2	168	38
There is a fistula between the gallbladder and another organ, it is necessary to suture the fistula	10	7				7
Calot area dissection						
Identification and dissection are standard	0	1005	711	51	89	4
Fatty or edematous, prolongs dissection time	1	720	36	549	48	7
Fibrous, but identifiable and detachable (possible injury on detachment).	5	162		8	83	21
Fibrous, identified with the help of additional interventions (intraoperative cholangiography, US, injection of a contrast agent, fundus-down cholecystectomy, etc.)	5	80		2	27	36
Fibrous, not identified, dissection is dangerous, alternative treatment is used: cholecystostomy, partial cholecystectomy, drainage, laparotomy, etc.	10	15			3	7
There are collaterals, therefore dissection with bleeding (from collaterals in liver cirrhosis and portal vein thrombosis)	10	13			4	9
Dissection of cystic artery and cystic duct						
Standard (clips)	0	1815	736	593	197	35
Ligation or suturing	1	136	11	13	48	14
There is an abnormality of the cystic artery and	5	26		4	9	13

cystic duct (possibly damage requiring cholangiography)						
Mirizzi syndrome type 1 or 2 (additional procedures are required, such as cholangiography and drainage of the choledochus, etc.)	10	10				14
Destruction in the area of junction of the cystic duct and choledochus (an additional operation is required: drainage of the choledochus)	10	8				8
Separation of the gallbladder from the bed						
Bed without adhesions, standard dissection is carried out	0	1090	710	59	96	17
Edematous or mesentery present (bleeding or exudate on dissection, continuous aspiration required)	1	613	23	479	37	14
There are Luschka's duct (clipping is required)	1	49	14	27	6	
There is necrosis and abscess in the bed (necrectomy is necessary)	1	68		37	23	8
There are fibrous adhesions that are easily detached (possible liver damage)	5	152		8	91	23
There are fibrous adhesions that do not separate, liver resection is performed	10	9			1	8
The dissection is bleeding, cannot be continued, and alternative surgery (partial cholecystectomy or cholecystostomy) may be chosen	10	11				11
Gallbladder located intrahepatic (requires hepatotomy)	10	3				3
Removal of the gallbladder						
Standard	0	1537	702	392	138	45
Removal by widening the incision	1	356	38	175	87	21
Removal of parts of the gallbladder piece by piece	1	102	7	43	29	18
Complications						
None	0	1857	732	591	223	7
Due to illness						
Diffuse bile peritonitis (sanation and drainage of the peritoneum)	10	8			1	6
Choledocholithiasis, cholangitis (drainage of choledoch, removal of stones from choledoch)	10	93			4	61
Pancreatitis (peripancreatic drainage, etc.)	10	37			2	34
Due to surgery						
Bleeding - stopped by cauterization	1	48	12	10	17	4
Bleeding - stopped by suturing	1	24	3	9	6	4
Organ damage – require suturing	10	6			1	5
Vascular injuries – requiring suturing of vessels (pulmonary artery, portal vein, etc.)	15	2				2
Organ injuries – requiring reconstruction (bile ducts, etc.)	15	2				2
	Total	1695 100	747 44	610 35.	254 14.	84 4.9

		%	%	9%	9%	%
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Discussion and conclusion

As one of the most frequently performed surgeries, LC is widely used in the treatment of both uncomplicated and complicated gallbladder diseases. Technically, in addition to a simple variant of this operation, some technical difficulties occur in about 50% of patients. To date, there are no standardized answers to questions such as "what is the indicator of the complexity of the operation?", "how is the degree of complexity determined?" regarding LC. While the definition of complexity is one of the important indicators for determining the activities of surgeons and hospitals, the results of scientific researches, the causes of complications. In studies, various indicators have been proposed to determine and evaluate complexity, which can be attributed mainly to conversion, operation time, inflammatory-destructive changes in and around the gallbladder.

At the initial stage, complications and conversion were considered as the main indicators of LC complexity. However, with increasing experience, many associated complications began to be resolved laparoscopically, the number of conversions decreased, and this indicator began to lose its significance as a criterion of complexity. Of course, pathological changes in and around the gallbladder play a key role in causing problems during surgery. Various studies have attempted to determine the degree of complexity based on the nature of these changes. According to the Tokyo classification, acute cholecystitis has 3 degrees of severity according to changes in the gallbladder and organ failure; so, at III grade, it is suggested that cholecystectomy will be difficult after more than 72 hours and the presence of a palpable bladder. In another study, acute cholecystitis was graded according to the nature of the inflammatory changes in the Calot area and around the gallbladder. Thickening of the gallbladder wall, tension of the gallbladder, and other similar indicators are presented as indicators of difficulty [11,12]. The duration of the operation is considered as the most important indicator of complexity in most studies. Some authors proceed from the total duration of the operation, others from the duration of the dissection of the Calot area. Schernek and HM note the duration of the operation more than 60 minutes, Lal and HM – more than 90 minutes. As the main criteria, some authors take the duration of dissection of the vessels and duct more than 20 minutes, while others more than 90 minutes. With regard to operative time, it should be noted that dissection time may decrease with increasing experience [13,14]. On the other hand, the time required to separate intraabdominal adhesions and the time required to separate the fibrous Calot area may be the same, but the risk of complications is clearly different.

This classification, which we call problem-solving or intervention-oriented, has many features. First, this classification is based on additional interventions. Therefore, additional interventions were classified as simple, with a risk of complications and additional operations. Currently, problem-solving or treatment-oriented classifications are widely used in surgical practice, the most striking example of which is the Klavien-Dindo classification of postoperative complications [15].

Secondly, our classification also took into account changes around the gallbladder and the time factor.

Thirdly, our classification takes into account the difficulties that arise at all stages of laparoscopic surgery. Another aspect of classification is the availability of clinical and quantitative assessment options. This aspect allows numerical comparison both in grades and within grades when comparing results. Examples of such classifications are the Child and Child-Turcotte-Pugh classifications used to determine the severity of liver cirrhosis.

Thus, there are 4 degrees of severity of LC according to the classification based on the

nature of additional interventions used to solve the problems of IDP caused by pathological changes around the gallbladder and intraoperative complications: I grade – the absence of problems with IDP and performing a standard operation, II grade – problems with IDP, which are solved by simple additional interventions, III grade – problems with IDP, which are solved by additional interventions with a risk of complications, IV grade – cases requiring additional or alternative surgery.

One disadvantage of this classification is that it was applied to operations performed by a single author.

Consent

As per international standard or university standard, patient(s) written consent has been collected and preserved by the author(s).

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