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## FEATURES OF LAPAROSCOPIC CHOLECYSTECTOMY IN SPECIAL GROUPS OF PATIENTS

Currently, laparoscopic cholecystectomy is the gold standard in patients with symptomatic gallstone disease. About 90% of cholecystectomies are performed laparoscopically due to faster recovery, fewer complications, cost and cosmetic effect. In this study, we evaluated the features of laparoscopic cholecystectomy in general, as well as in obese patients, aged patients, and pregnant women. Carrying out LCE in the elderly, pregnant women and obese patients today does not cause big problems. The main thing is to take into account the characteristics of each patient. In the case of LCE in the elderly, careful preoperative preparation of the vascular, hemodynamic, and respiratory status should be carried out to prevent adverse events. And the optimal period for the safest laparoscopic surgery in pregnant women is the second trimester. It is also necessary to remember that proper preparation should be carried out in consultation with obstetricians and anesthesiologists. At the same time LCE can be performed safely and effectively in patients with even a high degree of obesity showing equally good results compared to patients with normal BMI. Laparoscopic cholecystectomy is safe in patients with Child-Pugh A cirrhosis and should be used with caution in patients with Child-Pugh B cirrhosis. For patients with Class C cirrhosis, laparoscopic surgery is not recommended.

**Keywords:** acute calculous cholecystitis, laparoscopic cholecystectomy, open cholecystectomy, cholelithiasis (gallstone disease).

### Introduction

Gallstone disease is one of the most common abdominal disorders [1]. Among diseases of the digestive system, cholelithiasis accounts for 15-20% [2,3]. However, 20-40% of patients with gallstone disease develop complications associated with gallstones as high as 1-3% per year. And in 10-15% of cases, acute calculous cholecystitis is the first clinical manifestation [4,5]. Thus, every year there is an increase in surgical interventions for calculous cholecystitis and its complications. Surgical treatment of cholelithiasis began more than 100 years ago. Over this period approaches and visions of surgical treatment have changed many times [6]. With the introduction of the laparoscopic method the length of hospital stay with cholecystectomy has decreased, and now laparoscopic cholecystectomy (LC) is widely recognized as an appropriate and safe treatment method, also due to its low invasiveness, injury rate and reduced rehabilitation period [7].

### History of LCE

Erich Muhe is a German professor who performed the first ever laparoscopic cholecystectomy

in 1985 using a galloscope-laparoscope he invented. But unfortunately, the medical community criticized and did not recognize the surgery he performed [8].

Today we can say that the author performed single-port cholecystectomy which was not only the first in the history of LCE, but also the first in the medical history: two years later, on March 17, 1987 Philippe Mouret was able to perform “laparoscopy, dissection of adhesions and cholecystectomy”, which immediately captured attention of the whole medical community [9]. By that time Erich Muhe had already performed 92 LCE surgeries [10]. The LCE operations of Mouret and Muhe differed in multiportality and the use of video monitors [11]. At the same time many ports increase postoperative pain, disrupt the aesthetics of the operation and increase the risk of complications such as hernias, wound infections, and hematomas [12]. Undoubtedly, any surgical intervention is a factor of aggression and injures body tissues due to the need to provide access to operative organs [13].

Since the beginning of the 21st century, surgery has undergone significant changes. The introduction and improvement of minimally invasive surgery has radically changed the idea of surgical trauma [14]. In the early 1990s LCE met all the standards of modern

medicine and gained worldwide recognition in clinical practice [15]. Thus, in 1992 the National Institutes of Health recognized it as a safe and effective treatment for almost all patients with gallstone disease [16].

Numerous advantages of laparoscopic surgery have now been proven, many of which are indicative in the treatment of any surgical pathology [17]. These advantages mainly include less surgical trauma, fewer postoperative complications (especially purulent-septic ones), a shorter recovery period, and a cosmetic effect [18].

### LCE in Kazakhstan

The Aktobe Regional Children's Hospital based at the Department of Pediatric Surgery of the Aktobe State Medical Institute was the first to perform endovideoscopic surgery in Kazakhstan under the supervision of Professor B.K. Dzhenalayev. Dr. V.I. Kotlobovsky paved the way in video laparoscopic operations in November 1991. He was the one to perform an appendectomy on a child. It is considered as the first laparoscopic operation on a child in the USSR.

The first videolaparoscopic cholecystectomy was performed by Academician M.A. Aliyev at the Scientific Center of Surgery named after Syzganov in May 1992. Subsequently, in 1994 a specialized department of endovideoscopic surgery was opened in the same center, where courses were organized for the training and advanced training of doctors in the field of endovideosurgery [19].

### Optimal Timing for LCE

Based on the timing of the general pathogenesis, acute inflammation usually abates in 72 hours after the onset of inflammation and becomes chronic inflammation [20]. Therefore it is theoretically expected that all patients with acute cholecystitis will devel-

op local and systemic inflammation within 72 hours of symptom onset, but local and systemic changes after this time may be unpredictable in different patients. The incidence of acute cholecystitis may decrease or may not improve, or even worsen, as is seen with delayed surgery. Therefore, it is assumed that cholecystectomy in the early stages of the disease can prevent the progression of cholecystitis during surgery, especially in severe complications associated with an increase in postoperative complications [21].

It may be considered that immediate cholecystectomy should be preferred over delayed cholecystectomy if possible within 72 hours of symptom onset. If symptoms persist for more than 72 hours at the time of surgery, then the timing of cholecystectomy should take into account other outcomes and risk factors [22].

Demand and interest in "scarless" surgery is currently undeniable, and minimally invasive surgical techniques represent a normal evolution. The benefits of less postoperative pain, fewer postoperative complications, and better cosmetic outcomes have been emphasized [23].

Usually laparoscopic cholecystectomy is recommended for patients with biliary-type symptoms or patients with complications of gallstone disease, as these patients are more likely to have recurrent and more severe symptoms.

### Technical Aspects of Laparoscopic Cholecystectomy

Four ports are used in LCE: 10- or 12-mm umbilical port for the camera; 10 mm epigastric port, which is installed 4 cm below the xyphoid process, entering to the right of the sap-motor ligament; two 5 mm trocars placed along the midclavicular line above the umbilicus and anterior axillary line 4–5 cm below the costal margin, respectively (Figure 1) [23].

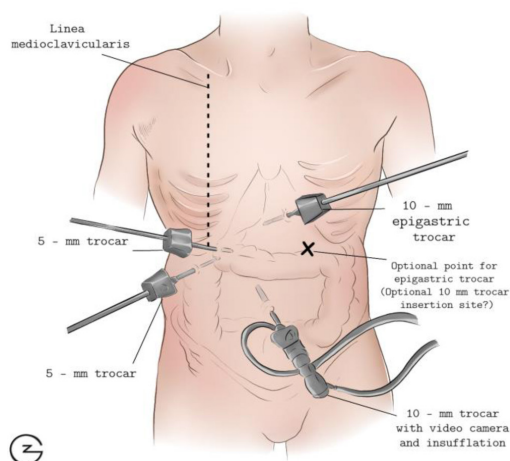


Figure 1 – Location of trocars or accesses

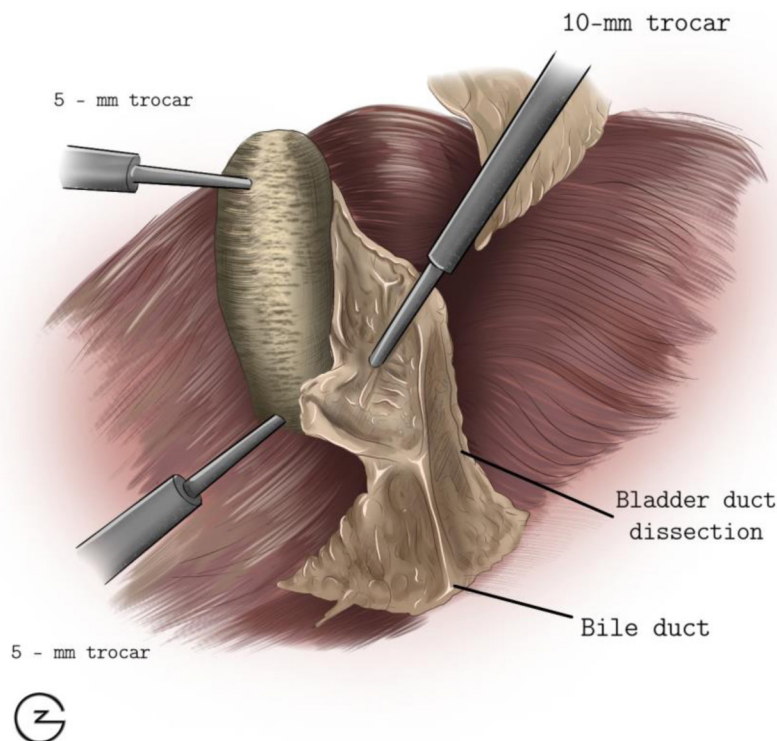
The operation is performed in the Trendelenburg position with the arms outstretched. An abdominal access is used when through the umbilicus a 10 mm casing is inserted which can be installed using a Hasson trocar or a Veress needle. The laparoscope must be inserted after insufflation of carbon dioxide up to 15 mm Hg with the abdominal cavity examined.

Based on data from clinical studies of the effect of pneumoperitoneal pressure reduction no difference observed in the average life expectancy of patients who underwent surgery with pressure  $\leq 10$  mm Hg and patients who were treated with a pressure of 10-15 mm Hg [24].

The patient is then placed in the reverse Trendelenburg position and tilted to the left to better visualize the gallbladder and surrounding structures.

Then under laparoscopic control two trocars are placed in the right hypochondrium and a 10-mm trocar in the epigastrium. Sometimes a fifth trocar is placed in the left hypochondrium for retraction, which makes it possible to better visualize the structures located in the hilum of the liver [25].

Traction of the gallbladder behind the fundus in the cranial direction and behind the neck to the right leads to tension of the cystic duct at a right angle to the common bile duct, thereby minimizing the chance of confusion between the 2 ducts (Fig. 2) [25].



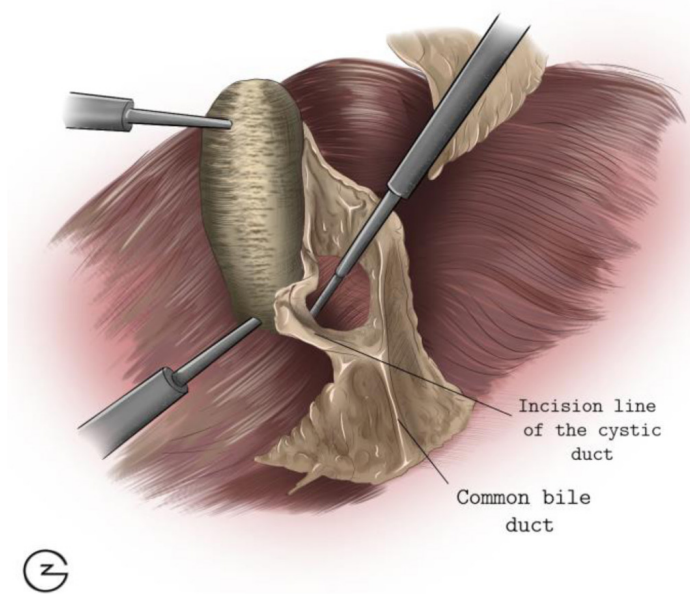
**Figure 2** – Traction and gallbladder dissection technique

The right-to-left dissection is then started, the cystic duct is identified, and sufficiently mobilized to be accurately identified [25].

An important aspect of dissection is retraction of the gallbladder fundus in the cranial direction and traction of the neck downward and laterally. The gallbladder neck must be carefully mobilized to expose the junction of the gallbladder to the cystic duct. Then a “window” or a “hole” is created and the in-

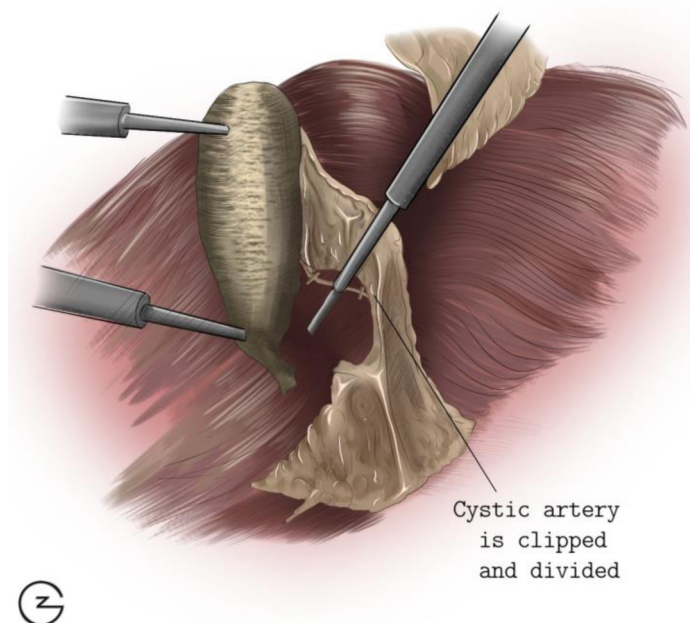
strument is passed behind the cystic duct and artery demonstrating the absence of other formations in this zone going to the gallbladder or liver.

This is a required safety measure. The clip on the cystic duct is applied no earlier than the complete dissection of the Calot triangle and the instrument is passed behind the cystic artery and duct. If there is even a shadow of doubt, upfront surgery should be performed [25].



**Figure 3 – Incision line of the cystic duct**

Then, two clips are placed on the proximal portion of the cystic duct and cut with scissors (Fig 3).



**Figure 4 – Identification and dissection of the cystic artery**

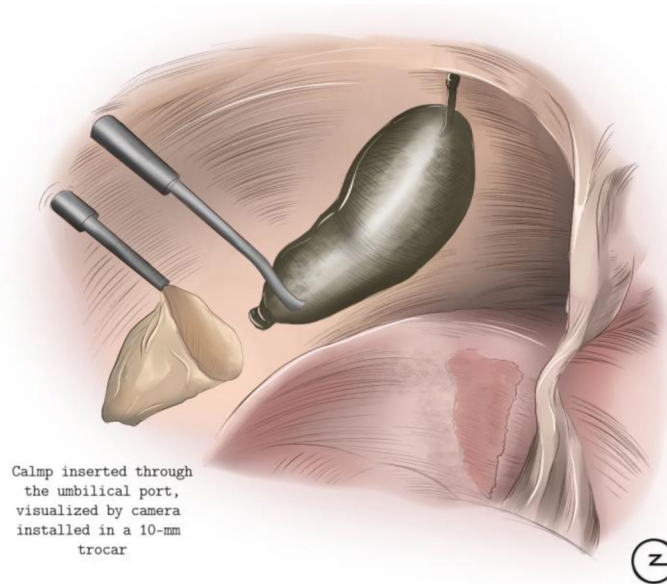
After transection the cystic duct, the dissection is continued to the left to expose the cystic artery. The cystic artery is transected after placing three clips (Fig. 4) [25].

The right and left transitional folds of the peritoneum are dissected using an electrocoagulator. When

dissecting the transitional fold of the peritoneum, the gallbladder is separated from its hepatic bed using an electric knife with care so as not to miss the additional bile ducts entering the gallbladder directly from the hepatic bed. Small foci of bleeding are controlled by electrocoagulation [25].

Next, the gallbladder is raised above the edge of the liver. A plastic container is inserted into the abdominal cavity through the umbilical port, into

which the gallbladder is placed. Then the container is closed and pulled out of the abdominal cavity (Fig. 5).



**Figure 5** – The gallbladder is removed using a plastic bag.

In case of large stones, it may be necessary to expand the incision of the aponeurosis or remove stones from the container, which shall be carried out avoiding wound contamination [25].

### Complications

Since laparoscopic cholecystectomy is the most frequently performed general surgical operation worldwide, this type of surgery correlates with an overall complication rate of 10% and is accompanied by a higher risk of biliary tract damage (0.1-1.5%) [26-28] than open cholecystectomy (0,1-0,2%) [26,29].

Factors predisposing to injury include anatomical features, pathology of the hepatobiliary tract, as well as incorrect identification of structures and the choice of incorrect tactics [30]. The most common cause of these lesions is due to misidentification of the common bile duct (CBD) or common hepatic duct (CHD) as a cystic duct or misidentification of the hepatic artery as a cystic artery [31].

Also the main problems leading to the development of complications include the lack of experience with the equipment, inability to perform cholangiography and a lack of understanding of electro-surgical principles. In addition, the cases may include “difficult gallbladder”, which are associated with adhe-

sions, obesity, inflammation or distension of the gallbladder and cirrhosis of the liver [32].

Considering the following factors: immediate morbidity, reduced quality of life and long-term survival, in addition to high mortality, which are associated with bile duct injury or biliary vascular injury, the strategy for safely performing LCE should not be underestimated [33]. Postoperative complications, especially life-long ones, significantly offset the benefits of a minimally invasive approach. Recent data suggest a downward trend in the incidence of bile duct injury (0.32%–0.52%) without a significant change in morbidity or mortality after LCE [29]. Based on this, it is important to understand that following a structured safe technical protocol helps to avoid injuries and negative outcomes of treatment.

### Features of LCE in special groups of patients

Laparoscopic cholecystectomy has revolutionized the treatment of gallbladder pathologies. However, despite all the advantages of this method of treatment, the surgical community is reluctant to use it in relation to the elderly patients. Although laparoscopy is well established in the treatment of a wide range of gallbladder diseases, the conservative surgical trend suggests that the outcome of laparoscopic cholecystectomy in the geriatric patient pop-

ulation is not well defined [34]. However, age alone should not be a contraindication for laparoscopic cholecystectomy.

Some sources say that many elderly patients have complicated abdominal access for LCE due to comorbidities, complications and adhesive processes after previous surgical interventions. The operation can be more complicated and take longer, but laparoscopy is considered feasible in emergency cases, as it is a safe method. Care is required for both trocar triangulation and pneumoperitoneum induction [35].

Regarding the postoperative period, the safety of performing LCE in geriatric patients has been proven, but the risk of postoperative cardiovascular complications is slightly higher. To prevent these adverse events in the elderly, it is necessary to conduct a thorough preoperative preparation of the vascular, hemodynamic, and respiratory statuses.

The level of systemic inflammation and sepsis was one of the main factors influencing the poor outcome of LCE in the elderly. Among comorbidities, diabetes has been associated with both increased surgical and postoperative cardiovascular morbidity, and previous stroke and chronic renal failure are correlated with a high risk of cardiovascular complications.

With proper perioperative care, older people can benefit from a minimally invasive approach that reduces postoperative complications and shortens the length of hospital stay [36].

Acute cholecystitis is the second most common cause of acute abdomen during pregnancy. The main problems during laparoscopic operations in pregnant patients are as follows: material damage during the introduction of trocars due to improper technique (which is especially difficult in the third trimester due to the severity of the uterus) and a decrease in venous return to the patient during the procedure after the pneumoperitoneum is attached and compression of the inferior vena cava. Despite this, it has been found that the benefits of laparoscopic cholecystectomy are greater than open surgery in pregnant women. Benefits include less postoperative pain [37].

Most operations included in various reviews were performed in the second trimester, which many surgeons consider the safest for laparoscopic surgery. There is concern that laparoscopy in the first trimester may lead to spontaneous miscarriage, however, there is currently insufficient evidence to support this statement [38].

Thus, LCE may be safe to perform in pregnant women, but the indications for it should be carefully considered, and adequate preparation should be carried out in consultation with obstetricians and anesthesiologists [39].

In addition, there is concern about the safety of LCE in obese people. Based on a 2015 study, LCE can be performed safely and effectively in even highly obese patients with equally good results compared to patients with normal BMI. The frequency of intraoperative complications was low: from 1% to 2% in different BMI groups. The rates of postoperative complications in the BMI groups < 40 groups were higher than in the other two BMI groups, but the differences were not as statistically significant [40].

The degree of obesity of patients affected the time of surgery but had no relation to the outcome. Despite the increase in the time of surgery, bleeding volume, conversion rate, complications and length of hospital stay remained within the normal range. Therefore, LCE can also be safely performed in obese patients with the same efficacy as in patients with a BMI within the normal range [41].

Gallstone disease occurs in approximately 47% of patients with cirrhosis [42,43]. These patients are subject to higher morbidity [44] and mortality compared with patients without cirrhosis [45]

When surgery is required for patients with hepatic fibrosis and portal hypertension due to increased risks of complications, open cholecystectomy is preferred over laparoscopic cholecystectomy [46,47,48]

Portal inflow in cirrhosis of the liver decreases, due to which the flow of the hepatic artery increases, as a compensatory mechanism. Based on this, it is recommended to maintain intra-abdominal pressure at a minimum level and conduct exsufflation carefully, intermittently [47].

At present, based on numerous studies, LCE has become the option of choice in specific cases [44, 47, 49]. However, the laparoscopic approach has certain disadvantages in liver cirrhosis and requires special precautions.

Laparoscopic cholecystectomy is safe in patients with Child-Pugh A cirrhosis and should be used with caution in patients with Child-Pugh B cirrhosis given the high conversion ratio [1].

If a patient has cirrhosis with Child-Pugh class C or MELD score >13, laparoscopic surgery is not recommended. In that case alternative options can be used such as partial cholecystectomy [50] or endoscopic gallbladder drainage [51,52]. Endoscopic papillary balloon dilatation without sphincterotomy correlates with a low risk of bleeding but has limited efficacy for large stones [53] Endoscopic treatment with mechanical lithotripsy or sphincterotomy is recommended in case of larger stones [53]

Some studies have shown that severe fibrosis and anatomical abnormalities are more common in men, and therefore laparoscopic cholecystectomy is more

difficult in men than in women. This is because the differentiated action of sex hormones may play an important role in wound healing. The effect of exogenous administration of low and high doses of estradiol to rats was studied. It was found that low doses of estradiol inhibit the formation of connective tissue by 29%, whereas high doses inhibit it by 65%. It was concluded that estradiol prevents the formation of connective tissue in peritoneal injuries depending on a dose. It has been suggested that estrogen may inhibit macrophage activation or prevent their accumulation in the wound, thereby inhibiting adhesion development. This difference may explain the difficulty in gaining surgical access during LCE and the higher frequency of transition to open surgery in male patients [54].

In the early years, laparoscopic cholecystectomy was considered unsafe or technically difficult for acute cholecystitis [55]. Gaining more experience, it was clear that the frequency of performing laparoscopic cholecystectomy for acute cholecystitis has increased, suggesting that it is technically feasible, but at the expense of a high conversion rate [56] and invasion of the common bile duct [57].

Routine open cholecystectomy may allow more patients to be operated on urgently. This is because most surgeons practice this particular method. But it is necessary to take into account the length of stay in the hospital and the impact on morbidity. In acute cholecystitis, laparoscopic cholecystectomy reduces postoperative morbidity, mortality, and the length of hospital stay [58]. Laparoscopic surgery also reduces the duration of operative time, the risk of developing pneumonia and wound infections [59].

## Methods and Materials

We searched the PubMed, Embase, Scopus databases and the Cochrane Research Library for guidelines, articles reviewing the laparoscopic method of cholecystectomy. In addition, a manual search for publication was carried out in such reputable journals as *Ann Surg*, *Lancet*, *BMJ*, *Brit J Surg*, *World J Gastroenterol*, *Surg Endosc*, *World J Surg*, *Am J Gastro-*

*enterol*, *Am J Surg*, *Langenbecks Arch Surg*, *Arch Surg*, *Chirurg*, *Jama Surgery*. The search included such words as acute cholecystitis, acute calculous cholecystitis, cholelithiasis, gallstones, laparoscopic cholecystectomy.

## Conclusion

Based on the review, it can be stated that the demand for and interest in “scarless” surgery is currently undeniable, and minimally invasive surgical methods represent a normal evolution. The benefits of less postoperative pain, fewer postoperative complications, and better cosmetic outcomes have been emphasized [21]. Carrying out LCE in the elderly, pregnant women and obese patients today does not cause big problems, the main thing is to take into account the characteristics of each patient. In the case of LCE in the elderly, careful preoperative preparation of the vascular, hemodynamic, and respiratory status should be carried out to prevent adverse events. And the optimal period for carrying out the safest laparoscopic surgical interventions in pregnant women is the second trimester. It is also necessary to remember that proper preparation should be carried out in consultation with obstetricians and anesthesiologists [38]. At the same time, LCE can be performed safely and effectively in even highly obese patients with equally good results compared to patients with normal BMI [40]. Laparoscopic cholecystectomy is safe in patients with Child-Pugh A cirrhosis and should be used with caution in patients with Child-Pugh B cirrhosis given the high conversion ratio [1]. If a patient has cirrhosis with Child-Pugh class C or MELD score >13, laparoscopic surgery is not recommended with alternative options to be offered such as partial cholecystectomy [50] or endoscopic gallbladder drainage [51,52]. Endoscopic papillary balloon dilatation without sphincterotomy is associated with a low risk of bleeding but has limited efficacy in case of large stones [53]. Endoscopic treatment with mechanical lithotripsy or sphincterotomy is recommended for larger stones [53].

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