Case report

BILE DUCT INJURY AFTER LAPAROSCOPIC CHOLECYSTECTOMY AND METHODS OF PREVENTION OF THIS COMPLICATION - CASE REPORT

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Rezume We described a case of successful treatment of common hepatic duct injury during laparoscopic cholecystectomy in a subject with acute calculous cholecystitis complicated with Mirrizzi syndrome. On the 3rd postoperative day following laparoscopic cholecystectomy, the patient developed mechanical jaundice and bile leakage from the abdominal drain. CT, MRCP, and ERCP have confirmed common hepatic duct injury (E3 according to the Strasberg-Bismuth classification). On the 10th day, the reconstructive operation with formation of hepaticojejunal anastomosis by Roux. In the article, we described methods for preventing bile duct injuries during laparoscopic cholecystectomy (critical view of safety, Rouviere's sulcus, "fundus-first" technique, subtotal cholecystectomy, and the use of fluorescent indocyanine green).

Key words: Laparoscopic cholecystectomy; Bile duct injury.

CASE PRESENTATION

Patient, female, 24 years old, arrived at the emergency department with pain in the right upper quadrant, which irradiated to the back; nausea and vomiting; temperature (38.5 C°); general weakness. Presenting symptoms, which occurred several days ago, were exacerbated on the day of arrival at the hospital.

Physical examination indicated positive Murphy's sign. Ultrasonography: sludge and calculus in the gallbladder. Ultrasound examination after patient repositioning revealed an immobile calculus in Hartmann's pouch. Diagnosis: acute calculous cholecystitis. The surgical team performed a Laparoscopic Cholecystectomy (LC) within a few hours, during which the surgeon encountered the following complicating factors:

1. Mirizzi syndrome has been diagnosed and classified as 3A according to the latest Carmen Payá-Llorente classification compiled in 2017 [1] (Fig. 1).
2. The gallbladder is located near the level of confluence, which could confuse the identification of important anatomical structures (Fig. 2).
3. Left and right intrahepatic ducts were located deep in the parenchyma, which made it impossible to identify the location and configuration of confluence.
4. The right intrahepatic duct passed in proximity to the wall of the gallbladder, which led to the accidental injury of the duct during the separation of the gallbladder from the visceral surface of the liver (Fig. 3).

During the first postoperative days, the patient presented with bile in the drainage, jaundice, and pain in the right subcostal area.

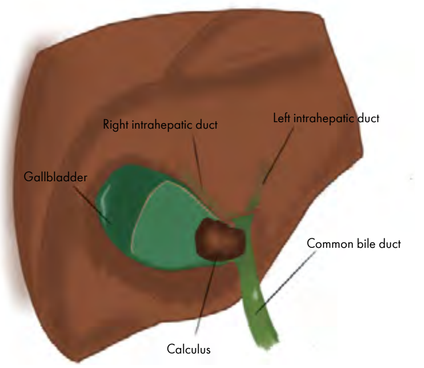

Figure 1. Preoperative picture of patient's bile ducts on arrival (13.09.2023)

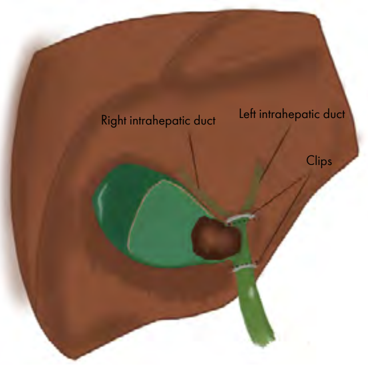

Figure 2. Clipping of common bile duct: proximal clip is 2-3 mm below confluence; The distal clip is on the common bile duct

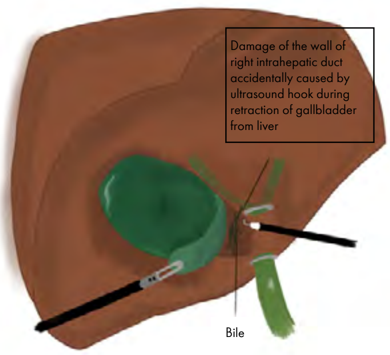

Figure 3. Damage of the wall of right intrahepatic duct during separation of gallbladder with ultrasound hook

Table 1. The table shows dynamic of dilatation of left hepatic duct during all intrahospital period

The date of investigation	The width of left hepatic duct
13.09 1st operation	4mm
15.09	4mm
20.9	5mm
22.09 ERCP; 2nd operation	6mm
26.09	4.8mm
30.09	2.5mm

On the 5th day after LC, an investigation of the bile ducts was conducted in axial/sagittal/portal planes using T2, FIESTA, and MRCP modes. Imaging revealed an insignificant amount of fluid collection and infiltrative changes within the postoperative abdominal cavity. Fluid collection persisted throughout the postoperative period until discharge.

The dynamics of left hepatic duct dilatation were traced from the moment the patient arrived at the clinic (table 1).

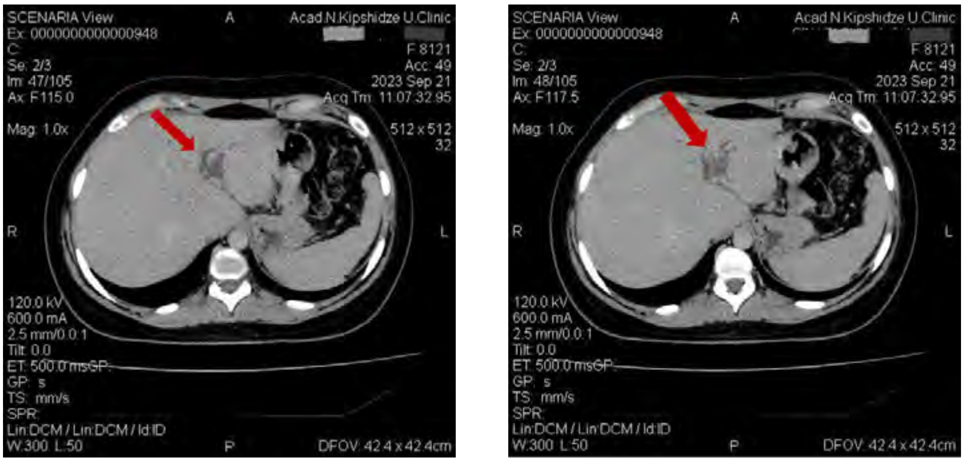

Figure 5. Damage of the wall of right intrahepatic duct during separation of gallbladder with ultrasound hook.

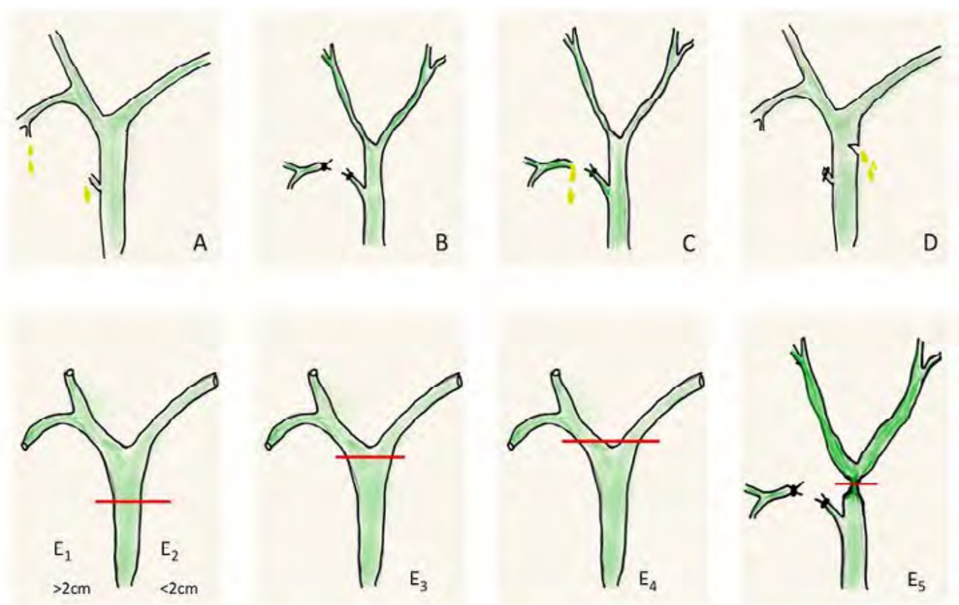

Figure 6. Bismuth-Strasberg classification of bile duct injury.
Resource: https://www.researchgate.net/figure/Bismuth-Strasberg-classification-of-bile-duct-injury-A-Bile-leak-from-cystic-duct-or_fig2_332358086

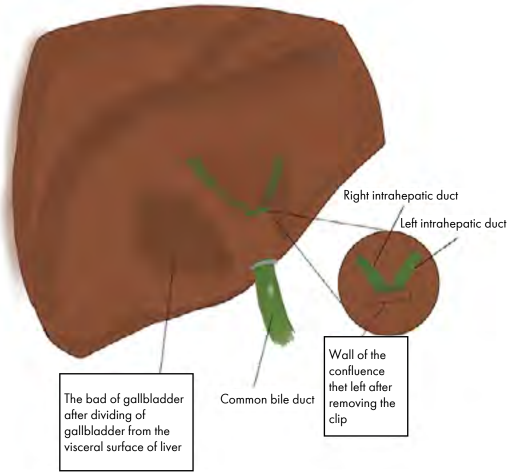

Figure 7. The picture of patient's bile ducts after LC

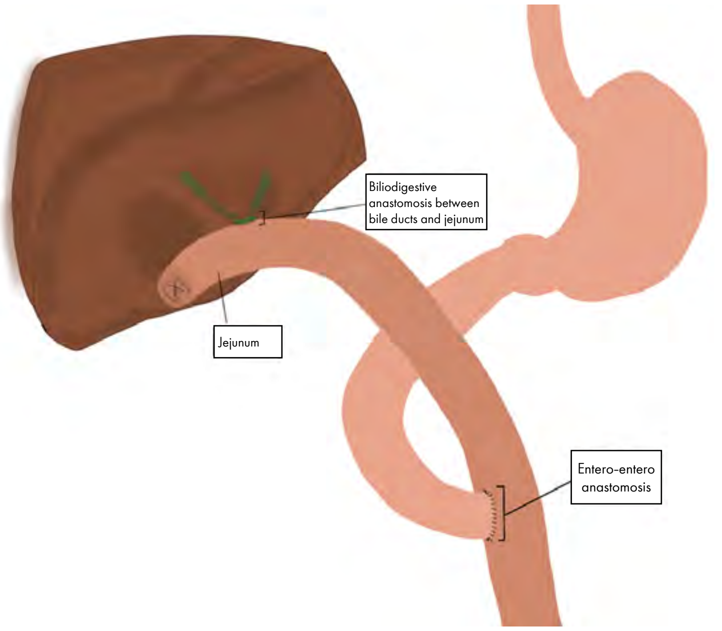

Figure 8. The result of reconsructive operation: billiodigestive anastomosis; formation of hepatojejunal anastomosis by Roux.

On the 8th day after LC, we conducted a Computer Tomography (CT) contrast in angiography mode and found a clip on the distal part of the right hepatic duct. The left hepatic duct is dilated, measuring 6 mm in diameter (normal up to 2 mm). Based on CT results, we identified an iatrogenic injury to the common bile duct near the confluence. (Fig.5)

After obtaining more detailed results from Endoscopic Retrograde Cholangiopancreatography (ERCP), it has been decided to proceed with a reconstructive operation. The laparotomy was conducted, during which surgeons found out that a proximal clip was placed 2-3 mm below confluence and the right intrahepatic duct had been damaged, which had led to bile leakage. The distal clip was placed on the Common Bile Duct (CBD). Part of the Common Hepatic Duct (CHD) between the proximal and distal clips was present. The patient had E3 biliary injury according to the Bismuth-Strasberg classification [2] (Fig. 6), so no confluence between the right and left hepatic ducts was considered. However, ducts were not fully divided. Damage was on the level of confluence, and the superior intrahepatic wall of this confluence was intact. (Fig. 7) Hepato-jejunal anastomosis by Roux was formed intraoperatively. (Fig. 8) Postoperative period passed without complications. The patient was discharged on the 12th

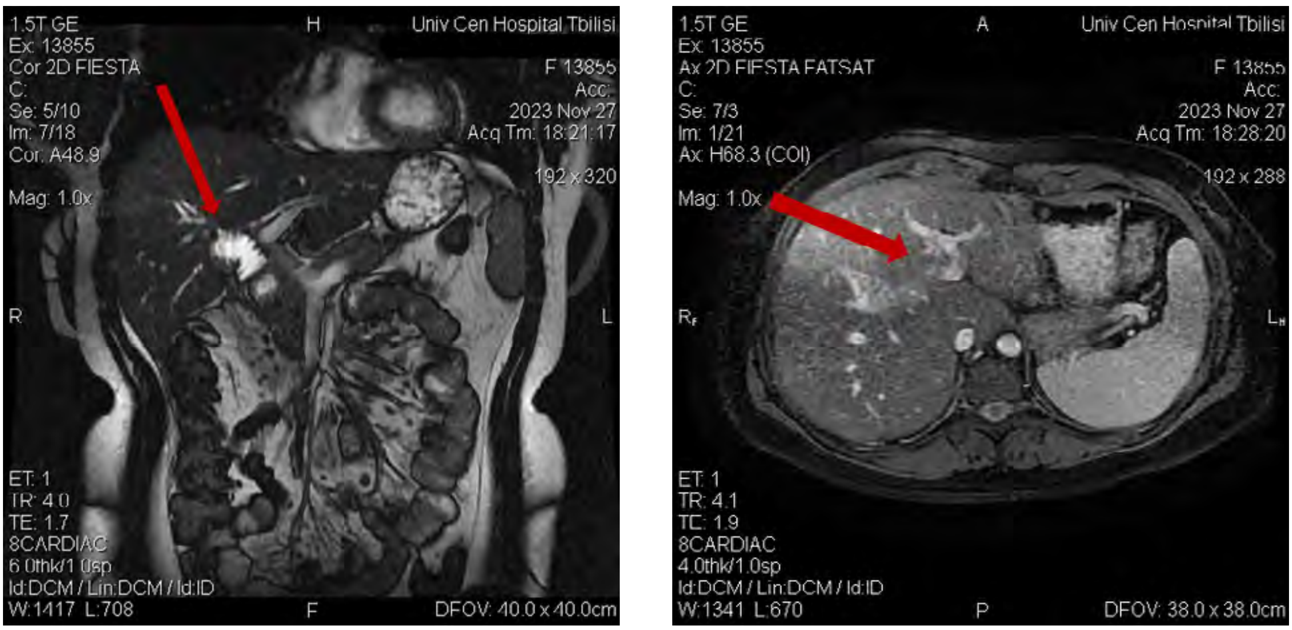

Figure 9. MRI and CT results in one month after reconstructive operation. The plces where anastomosis has been placed is pointed with arrow.

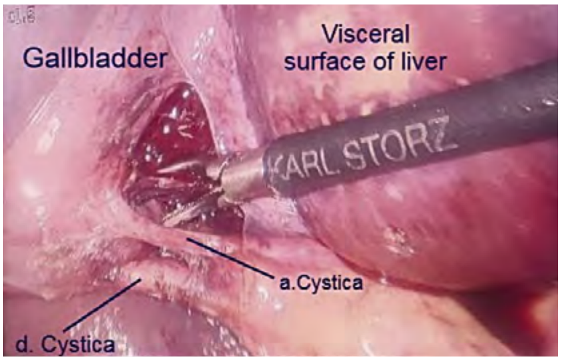

Figure 10. Clearance of surrounded tissue from hepatocystic triangle

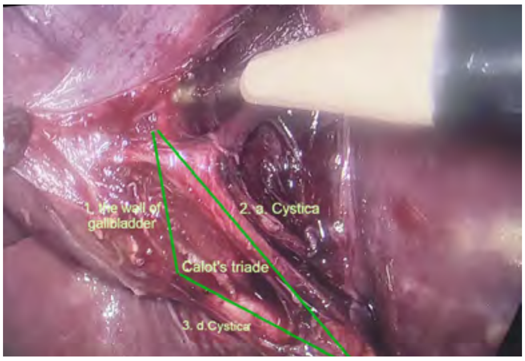

Figure 11. Visualisation of vascular structures (Calot's triangle)

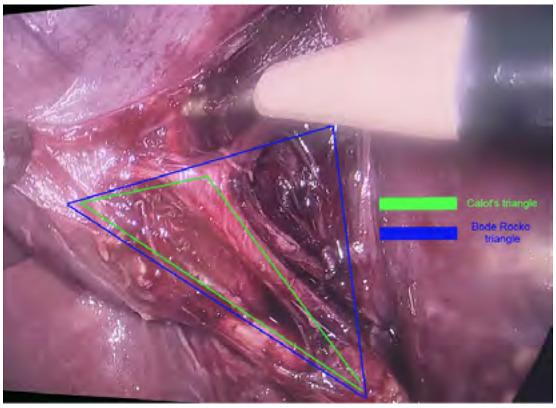

Figure 12. The difference between Calot's triangle and Bode Rocko triangle. Green: Calot's triangle; Blue: Bpde Rocko triangle.

postoperative day. The patient has returned to a common lifestyle in 6 months. (Fig. 9)

Iatrogenic injuries after LC occur in 0.5% of cases. In the present hepatobiliary surgery, some rules and techniques for conducting safe LC were highlighted.

1. CVS

First applied 30 years ago, Critical View of Safety (CVS) has become a gold standard for all surgeons performing laparoscopic cholecystectomy (LC).

This technique includes 3 steps:

1. Dissection of the surrounding tissue from important vascular structures. (Fig. 10)
2. Separation of the lower 1/3 of the gallbladder from the liver.
3. Visualisation of vascular structures. [3]

According to the Tokyo Guidelines 2018 (TG18) [4], surgeons should adhere to the 3 steps of CVS to minimize the risk of Bile Duct Injury (BDI) and cystic artery bleeding.

In this technique, the key role is played by Calot's triangle, the borders of which are formed by crucial structures that should be identified precisely: the cystic duct (laterally), the cystic artery (superiorly), and the common bile duct (medially). (Fig. 11) Throughout these years, Calot's triangle has become an inevitable part of LC. However, sometimes, if the liver margin is counted as the upper border of the triangle, it is modified in the Bode Rock triangle (hepatocystic). (Fig. 12) As the cystic artery (which is traditionally considered as the upper board of Calot's triangle) has different variants of performing and can compromise the CVS, the Bode Rocko triangle is considered a safe and clear method for conducting CVS. First, the inferior margin of the liver is a constant structure with no anatomical variations. Another point is that in the Bode-Rocko triangle, surgeons can identify the Lund or Moskagni node, which is also a helpful landmark in patients with normal BMI. [1]

Despite its advantages and the need to provide CVS, this technique falls short of accurately representing the biliary tree's unconventional anatomy. For instance, according to the prevalence-based classification of anatomical biliary variants [6], the presence of type 4 and type 5 variants can lead to misinterpretation of the patient's anatomy, with subsequent postoperative complications even with conducted CVS. This fact also represents the usefulness of using the Bode Rocko triangle instead of Calot's triangle. Moreover, Mirrizzi syndrome also makes it impossible for a surgeon to visualize vascular structures and skeletonize them. In such cases, CVS fails, and the gold standard for resolution of these situations is subtotal cholecystectomy, which will be considered later.

2. Rouviere's sulcus (RS)

For surgeons, it is also important to precisely determine the level of soft-tissue dissection due to the high risk of Common Bile Duct Injury (CBDI) and Cystic Artery Bleeding (CAB).

This line is placed between Rouviere's sulcus and the umbilical ligament. Rouviere's line allows defining the safe level of manipulation in the Bode Rocko triangle area to avoid complications [5]. Thus, after representing this imaginary line, the surgeon should adhere to the rule which can be briefly formulated as "over-done, under-none!", so the operator should not work under the level of Rouviere's line.

Rouviere's sulcus is used during both LC and open cholecystectomy. Though during LC, the visualisation of this structure is better. Rouviere's sulcus can be seen as either a white line or a true sulcus. It can be classified according to profundity and appearance: open, closed, slit, and scar [7]. The open sulcus continues to the porta hepatis and can be measured with length, breadth, and depth. Closed sulcus is partly visible and looks like a fossa in the parenchyma of the Vth segment. Slit sulcus is the last visible grade of sulcus, where only length can be measured. The scar sulcus appears as a white line with no relief differences compared to the surrounding parenchymatous tissues.

Nevertheless, in some patients, we cannot detect Rouviere's sulcus, which may be an anatomical variation. In this case, it becomes impossible to use this landmark.

3. "Fundus-first" technique

In some cases, when CVS fails and a traditional approach is not feasible, the "fundus-first" technique is the last step before more radical bailout strategies, such as subtotal cholecystectomy or conversion to open cholecystectomy.

The concept of "fundus-first", also known as "fundus down", "retrograde cholecystectomy" or "dome down", differs from the traditional approach only at the beginning, from the fundus of the gallbladder, because the CVS cannot be completed. The reasons can include: adhesions in the area of Calot's triangle or the Bode-Rocko triangle; severe inflammation; BMI ≤ 30; Mirrizzi syndrome; an anomalous bile duct; necrotic changes around the gallbladder and in Calot's triangle; and other reasons. Beginning with the dissection of the gallbladder from the visceral surface of the liver, the procedure proceeds to the cystic duct and cystic artery, culminating in their visualisation and clipping. Thus, "fundus-first" allows precise identification of the structures entering the gallbladder and clips them [8].

"Fundus-first" technique is a controversial way of conducting cholecystectomy because it is associated with a high risk of Vascular-Billiar Injury (VBI). Anatomical variations in the elements of the porta hepatis make it impossible for the surgeon to reduce the risk of VBI, especially in patients with chronic inflammation, biliary inflammatory fusion, and contraction [9]. Moreover, clipping the cystic artery at the end of gallbladder retraction is associated with greater blood loss during the operation [5].

Though, the dissection about merits and demerits of this technique continue, Society of American Gastroenterologists and Endoscopic Surgeons (SAGES) gives a recommendation: "When the critical view of safety cannot be achieved and other methods during laparoscopic cholecystectomy cannot clearly define the biliary anatomy, we suggest that surgeons consider subtotal cholecystectomy over total cholecystectomy by the fundus-first (top down) approach (expert opinion)" [10]. Moreover, the Tokyo Guidelines 2018 state that, in cases of severe inflammation of the Calot's triangle, this technique can offer an alternative to LC without risk of BDI or conversion to open cholecystectomy [4].

4. Subtotal cholecystectomy

Subtotal cholecystectomy (STC) is one of the bailout procedures that allows for gallbladder removal in cases when CVS is impossible to achieve. STC is the last feasible laparoscopic way of treating acute cholecystitis before the last existing option- open cholecystectomy, which is associated with high risks of complications.

STC can be divided into 2 types: fenestrating and reconstituting.

I - Fenestrating STC

The fenestrating way of conducting STC includes the excision of the peritonealised part of the gallbladder; extraction of the content of the gallbladder, and closure of the cystic duct from inside the gallbladder using a purse-string suture. [11]

While excising the peritonealised part of the gallbladder, the surgeon should leave the lowest edge. This part serves as a "shield" to help prevent BDI while working in Hartman's pouch. This landmark, called the "shield" of McElmoyle, is presented as an important detail in fenestrating STC [11] (Fig. 13).

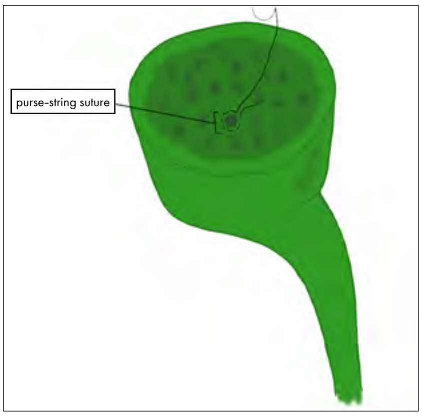

Figure 13. Fenestrating STC

Figure 14. Reconstituting STC; the stump

II - Reconstituting STC

The difference between fenestrating and reconstituting STC lies in the last steps: in reconstituting STC, the surgeon should close the remnant of the gallbladder with interrupted sutures, as shown in the picture (Fig 14) [11]

As we can see, the choice between fenestrating and reconstituting the STC depends on whether to close the cystic duct from within or leave the gallbladder stump.

Depending on the chosen technique, some advantages and disadvantages can be achieved. More preference is given to fenestrating STC because of decreased risks of postoperative complications, such as gallbladder remnant, associated with the lowest part of the gallbladder, which is left re-established as it performs in reconstituting STC. On the other hand, the use of fenestrating STC can lead to the incidence of bile fistula, and this kind of complication is less likely to occur after reconstituting STC. However, it was concluded that of these 2 postoperative complications, the bile fistula is less problematic, as it has resolved spontaneously in many patients [11]. In contradiction to this, gallbladder remnant exacerbated the quality of patients' lives, causing pain, jaundice, and fever, so it requires reoperation.

The most reasonable decision in cases with STC to reduce the risk of complications is to perform it in a reconstructive manner using that small stump, which can be equivalent to cystic duct closure, as in fenestrating STC [11].

5. Fluorescent Indocyanin Green

Using Indocyanin Green (ICG) during acute cholecystectomy is a relatively new method of visualisation of bile ducts in patients with severe inflammation, Mirrizzi syndrome, and bile duct or gallbladder tumors [12].

To provide an LC with augmented reality, the clinic should have special equipment that compares two wavelength-isolated light sources: a white light source and a near-infrared light source. When ICG is administered, it is metabolized within 2-5 min and excreted by the liver cells within 10 min. Lightning reaches its peak in 2-2,5 hours [13]. That is why, in elective cases, the use of ICG is more relevant than in urgent operations, where time plays a key role. At the same time, visualization of bile ducts using ICG is more necessary in urgent cholecystectomies. However, the fluorescent pigment's representation can take a comparatively long time in an emergency.

ICG can be used not only for BDI prediction, but also for bleeding prevention. When a surgeon has difficulty identifying the cystic artery, the i/v injection of ICG solution can be used. This intraoperative administration method can provide visualisation of the artery in 20-40 sec over a 20-30 sec period [13].

The SAGES recommends ICG integration LC routine: "We suggest that the use of near-infrared imaging can be considered as an adjunct to white light alone for identification of biliary anatomy during cholecystectomy. Guideline Development Group (GDG) noted that relying on near-infrared imaging must not be a substitute for good dissection and identification technique (expert opinion)" [10].

This modern way of predicting BDI and bleeding has its own advantages and disadvantages, presented in the table below (Table 2).

Table 2. Advantages and disatvantages of using ICG imagingduring LC

Advantages of ICG imaging	Disadvantages of ICG imaging
1. Ability to provide individual approach to patients' anatomy	1. High price of ICG liquid
2. Visualisation of feasible aberrant ducts	2. Complementary special equipment.
3. Ability of visualizing either ducts or arteria	3. Long representation time
4. Control of bile leakage as a result of BDI during all steps of operations	4. Difficulties in exploitation during emergence operations because relatevely long time of representation (1.5 - 2 h)
5. Ability to visualise bile ducts in patient with Mirrizzi syndrome and primary or secondary tumors of bile ducts	5. Possible allergic reactions, including intraoperation anaphylaxis

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საკვანძო სიტყვები: ლაპაროსკოპიული ქოლეცისტექტომია; სანაღვლე სადინრის დაზიანება.

FEATURES OF OPEN SURGICAL TRACHEOSTOMY IN INTENSIVE CARE UNIT (ICU) PATIENTS

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Rezume Tracheostomy is the most common procedure in the intensive care unit. Its indication is mainly prolonged intubation. Various studies have determined that 10% of intubated patients require a tracheostomy.

The article discusses the anatomical features of the neck, trachea, and thyroid gland. 70 cases of open surgical tracheostomy performed in intensive care patients over a continuous two-year period are presented, including 53 (75.7%) patients over 60 years of age.

The importance of correct positioning of the patient on the operating table and selection of a skin incision on the anterior surface of the neck is presented. Technical aspects of the operation, selection of the correct localization of the tracheal incision by the surgical team. In intensive care patients, preference is given to relatively "high" tracheostomies, mobilization of the isthmus and edges of the thyroid gland.

Open surgical tracheostomy in intensive care patients is not an easy operation to perform. The operation must be performed in an operating room with appropriate equipment, by a suitably qualified team.

Key words: Tracheostomy; Open Surgical Technique; Intensive Care Unit; Mechanical Ventilation; Thyroid Gland Anatomy.

Tracheostomy represents one of the oldest known surgical procedures, with images dating back to 3600 BC. In the early twentieth century, Chevalier Jackson established the principles of tracheostomy, which clinicians still follow today [1,2,3].

The term "tracheostomy" refers to the surgical creation of a stoma that opens the trachea onto the anterior surface of the neck.

Tracheostomy currently constitutes the most common surgical procedure in patients receiving mechanical ventilation. Various studies report that intensive care unit physicians perform tracheostomy in approximately 10% of ICU patients. The main indications for this procedure include prolonged endotracheal intubation, frequent lower airway clearance, and upper airway obstruction [1,6]. Many authors consider it appropriate to perform tracheostomy after 9–10 days of intubation [1,2,5].

Although tracheostomy is the most frequently performed surgical procedure in intensive care patients, surgeons have not yet established a single, universally accepted method [5]. We usually describe the tracheostomy as upper, middle, or lower, in relation to the thyroid isthmus. Because the anatomical relationships vary considerably, the terms "upper" and "lower" do not always correspond to "high" and "low" tracheostomy. This has been emphasized by V.S. Lyande (1957) and M.K. Perelman (1972) [6].

According to various authors, the trachea consists of 16–20 or 18–22 cartilaginous rings. In the cervical region, surgeons usually identify 4–5 rings; every 1 cm of tracheal length contains roughly two rings, each about 4 mm wide. On average, the trachea measures 10–13 cm in men and is shorter in women.

The isthmus of the thyroid gland most commonly overlies the 2nd to 4th tracheal rings [3,4,7].

The anatomical configuration of the thyroid gland also plays an important role. In 1895, C.F. Marshall noted that it is difficult to define a single "normal" anatomy of the thyroid gland. He proposed a classification based on differences in the presence and position of the pyramidal lobe and described 17 distinct forms [7].

Large-scale studies from the UK, which analyzed 70 general intensive care units, showed that performing a tracheostomy within the first 4 days of ICU care does not reduce mortality. These studies also demonstrated that intensive care physicians cannot reliably predict which patients will ultimately require tracheostomy [1,2,5,6].

In 1998–2000, M.A. Ognerubov and co-authors described 12 variants of thyroid morphology:

1. Pyramidal lobe on the right (12%)
2. Pyramidal lobe in the center (17%)
3. Pyramidal lobe on the left (31.4%)
4. Butterfly-shaped (30.6%)
5. Without a bridge (lobes separated) (21.7%)
6. Asymmetrical (11.2%)
7. Large and wide isthmus (8%)
8. Thin and narrow isthmus (8.25%)