Effect of upper abdominal incisions on the feasibility and outcomes of laparoscopic cholecystectomy

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Abstract:

Laparoscopic cholecystectomy remains one of the most commonly performed procedures in the United States and worldwide. Although the laparoscopic approach is considered safe, complications are still prevalent and occur in 6–8% of patients. Despite its relative infrequency, the most serious major complication is bile duct injury, which is a major cause of morbidity and mortality. Bile duct injury can convert a potential outpatient procedure into one requiring further operative interventions, additional costs, and a significant negative impact on the patient.

Keywords: Laparoscopic, Cholecystectomy, bile duct injury.

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Introduction:

Most authors would suggest that it is safe to observe patients with asymptomatic gallstones, with cholecystectomy being performed only for patients who develop symptoms or complications of their gallstones ***(1).*** However, Prophylactic cholecystectomy for asymptomatic cholelithiasis can be justified in certain circumstances, such as in diabetic patients, patients with sickle cell disease, those undergoing open bariatric surgery, those requiring long-term total parental nutrition, or patients who are therapeutically immune-suppressed after solid organ transplantation, as these groups are at increased risk of complications from gallstones ***(2).***Surgical cholecystectomy remains the only curative option for most gall bladder disorders and is performed using either open or laparoscopic methods.

The first successful open cholecystectomy for gallbladder stones was performed by Langenbuch in Berlin on July 15, 1882. Since then, open cholecystectomy had been the gold standard treatment of calcular cholecystitis till the late 1980s,when Philip Mouret from France performed the first video

assisted laparoscopic cholecystectomy as we know it today in 1987 ***(3).***However, earlier, the German surgeon Erich Mühe performed the first laparoscopic cholecystectomy in 1985 when he completed the world's first complete laparoscopic removal of the gallbladder in less than two hours. By 1987, Mühe had performed almost 100 endoscopic laparoscopic cholestectomies, giving Mühe himself reason to call the procedure "magic."He presented his experience at the Congress of the German Surgical Society (GSS) in April of 1986***(4).***

In 1987, Phillipe Mouret in Lyon has generally been given credit for developing the first video-assisted laparoscopic cholecystectomy as we know it today. Shortly thereafter, François Dubois in Paris and Jacques Perissat in Bordeaux began performing laparoscopic cholecystectomies. In 1989, Perissat was met with great interest at the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) meeting for his video on laparoscopic cholecystectomy, and Dubois published the first series on Annals of Surgery in 1990. Simultaneously to what the French were achieving, the American surgeons Barry McKernan and William Saye performed the first laparoscopic cholecystectomy in the United States in 1988 ***(5).***Laparoscopic cholecystectomy is currently the gold standard treatment for symptomatic gallstone disease. It is the most commonly performed minimally access surgery by general surgeons worldwide. In Europe and America, 98% of all cholecystectomies are performed by laparoscopy ***(6).***

Laparoscopic cholecystectomy decreases postoperative pain, decreases the need for postoperative analgesia, shortens the hospital stay from 1 week to less than 24 hours, and returns the patient to full activity within 1 week (compared with 1 month after open cholecystectomy); laparoscopic cholecystectomy also improves cosmosis and patient satisfaction compared with open cholecystectomy ***(7).*** Although it is true that no surgery has been more profoundly affected by the advent of laparoscopy than cholecystectomy, it is equally true that no procedure has been more instrumental in ushering in the laparoscopic age than laparoscopic cholecystectomy ***(8).***

The general indications for laparoscopic cholecystectomy were the same as those for the corresponding open procedure. Although laparoscopic cholecystectomy was originally reserved for young and thin patients, it is now also offered to elderly and obese patients; in fact, these latter patients may benefit even more from surgery through small incisions***(9).***

Common Indications are:

- Cholelithiasis (chronic calcular cholecystitis).
- Mucocele gall bladder.
- Empyema gall bladder.
- Cholesterosis.
- Typhoid carrier.
- Porcelain gallbladder.
- Acute Cholecystitis (calculous and

acalculous).

- Adenomatous gall bladder polyps.
- As part of other procedures as Whipples procedure.

Laparoscopic cholecystectomy remains an extremely safe procedure, with a mortality of 0.22-0.4%.Major morbidity occurs in approximately 5% of patients***(10).***

Complications include the following:

- Trocar/Veress needle injury (vascular or intestinal)
- Hemorrhage
- Post cholecystectomy syndrome
- CBD injury or stricture
- Wound infection or abscess
- Ileus
- Gallstone spillage
- Deep vein thrombosis

The most commonly used surgical technique in laparoscopic cholecystectomy is the infundibular approach, characterized by dissection of the Calot triangle, clipping of the cystic artery, and the cystic duct ***(11).*** Rouviere's sulcus is a fissure on the liver between the right lobe and caudate process, and is clearly seen during an LC during posterior dissection in the majority of patients. It was first identified in 1924 by Henri Rouviere. This corresponds to the level of the porta hepatis, where the right pedicle enters the liver. Therefore, it has been recommended that all dissections be kept to a level above (or anterior) to this sulcus to avoid injury to the bile duct as an extra biliary fixed anatomical landmark that is not affected by distortion due to pathology ***(12).*** Bile duct injuries are encountered in 0.3% to 0.5% of laparoscopic cholecystectomies. To decrease the incidence of bile duct injuries in LC, Strasberg et al. introduced the critical view of safety (CVS) technique in 1995. Hydrodissection is another technique used in difficult cholecystectomies **(13).** Currently, the CVS technique is accepted as the most effective method for reducingmorbidity and mortality associated with laparoscopic cholecystectomy. The EuropeanAssociation of Endoscopic Surgery (EAES) recommends CVS as the most effective approach for preventing bile duct injuries ***(13).*** This technique is based on the principle that Calot's triangle must be dissected free of fat, fibrous, and areolar tissue, with the lower end of the gallbladder dissected off the liver bed. At this point, only two tubular structures (cystic duct and artery) should enter the gallbladder directly from the hepatoduodenal ligament, with the surface of the liver bed clearly visible. This confirms the absence of abnormal regional anatomy and reduces the risk of common bile duct (CBD) injury ***(13).***

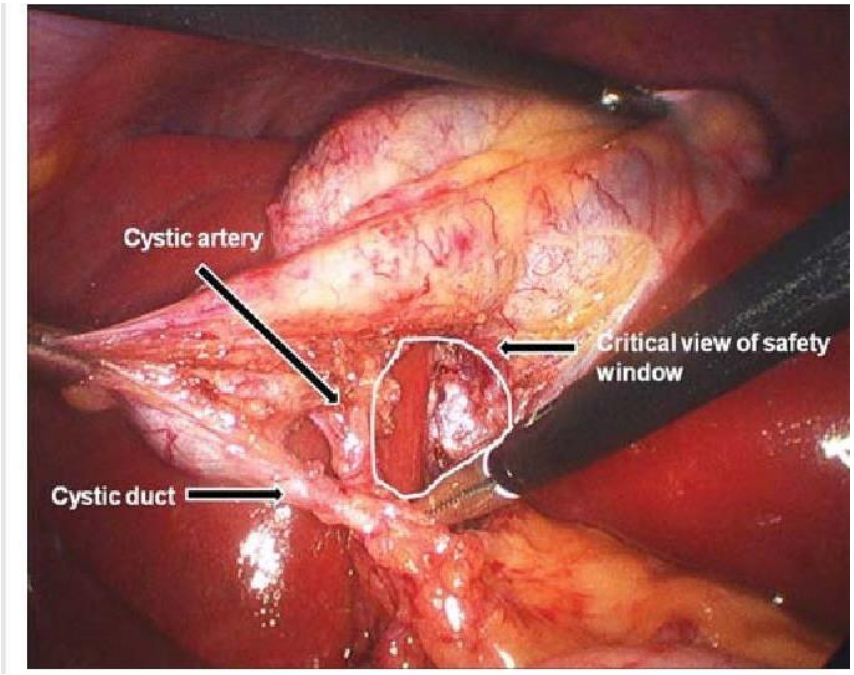

Figure (1): Critical view of safety ***(13).***

Absolute contraindications for laparoscopic cholecystectomy:

An inability to tolerate general anesthesia and uncontrolled coagulopathy, generalized peritonitis, septic shock from cholangitis, severe acute pancreatitis, patients with severe obstructive pulmonary disease, congestive heart failure (e.g., cardiac ejection fraction <20%) may not tolerate carbon dioxide pneumoperitoneum and may be better treated with open cholecystectomy if cholecystectomy is absolutely necessary. Gallbladder cancer must be considered a contraindication for laparoscopic cholecystectomy. If gallbladder cancer is diagnosed intraoperatively, the surgery must be converted to an open procedure ***(14).*** When laparoscopic cholecystectomy began in the early 1990s, pregnancy, previous abdominal surgery, obesity, cirrhosis, and acute cholecystitis were considered absolute contraindications for performing the laparoscopic technique. As advances in laparoscopic skills and instrumentation have evolved, a range of increasingly complex procedures have been performed, making all of these traditional contraindications at best relative and just requiring special care and preparation of the patient by the surgeon and careful weighing of risk against benefit.***(15).***

Previous upper abdominal surgery has been listed as a concern because of adhesion formation, which causes the bowel or other abdominal structures to adhere to the undersurface of the abdominal wall. The potential for bowel injury during trocar placement or difficulty in visualization of the hepatobiliary structures, as well as the necessity for adhesiolysis and its attendant complications, have prevented some surgeons from using the laparoscopic procedure in patients with previous upper abdominal surgery. On the other hand, the chances of unwanted surprises, such as

dense adhesions, awaiting the surgeon during LC, are the same as those encountered during open cholecystectomy. With increasing experience, many surgeons have felt that laparoscopic cholecystectomy is feasible in such patients (16). Almost all patients develop adhesions after transperitoneal surgery, and their prevalence after major abdominal procedures has been evaluated at 63%-97%. Colorectal surgery has proven to be the most important type of surgery that may cause intra-abdominal adhesions (17). Adhesions can be formed between every intraperitoneal organ and damaged serosal layer, but adhesions between the omentum and the wound are the most common; adhesions can also be formed between the liver and diaphragm surface to the abdominal wall; the gastric antrum, small intestine, and colon may adhere to the abdominal wall or to the right side of the round ligament of the liver, shifting them upward to block the porta hepatis, leading to the disappearance of the lacunar space in the right inferior liver(18).

Among postoperative adhesion formation, Three processes can be distinguished: adhesion formation (adhesions formed at operative sites), de novo adhesion formation (adhesions formed at non-operative sites), and adhesion reformation (adhesions formed after the lysis of previous adhesions) ***(18).*** The risk and extent of adhesions seem to depend on several factors, including the type of incision, number of previous laparotomies, damaged visceral or parietal peritoneum, intra-operative complications at the initial laparotomy, indication for surgery and laparoscopy, or laparotomy ***(18).***

Pathophysiology of adhesions:

The first peritoneal adhesions were described on the postmortem examination of a patient with peritoneal tuberculosis in 1836. To explain this finding, it was suggested in 1849 that coagulated lymphatic vessels may develop fibrinous adhesions. The exact pathophysiology of peritoneal adhesions remains controversial ***(19).***

Peritoneal adhesions are pathological bonds, usually between the omentum, loops of the bowel, and the abdominal wall. These bonds may be a thin film of connective tissue, a thick fibrous bridge containing blood vessels and nerve tissue, or direct contact between two organ surfaces that can be post inflammatory or post operative (the most frequent) ***(19).*** The mechanisms of adhesiogenesis are not well understood but are believed to involve mesothelial surface disruption with subsequent fibrino-coagulative and inflammatory signaling processes. According to etiology, peritoneal adhesions may be classified as congenital or acquired, which can generally be organized into the following categories:

Post-surgical: Nearly 90% of abdominal adhesions form as a result of prior abdominal surgery, primarily laparotomy (i.e., open surgery), and to a much lesser extent, laparoscopic surgery. In one study, intra-abdominal adhesion formation was noted intraoperatively in 95% of patients who had previously undergone laparotomy. The indications for initial laparotomy in this study were broad, ranging from gastrointestinal (GI) tract malignancy, benign small bowel disease, complicated appendectomy, cholecystectomy, hysterectomy, or ectopic pregnancy.The extent of adhesion seemed

to correlate with the severity and extent of the underlying initial process. Fortunately, the incidence of significant adhesions has decreased considerably in the era of laparoscopic surgery, with approximately only about 5% of such cases subsequently developing adhesive disease ***(20).***

Post-inflammatory or infectious: Endometriosis and pelvic inflammatory diseases are the most common etiologies of nonsurgical adhesions in women. Other etiologies affecting either sex include diverticular disease (particularly in the small bowel), Crohn's disease, and abdominal tuberculosis (in endemic areas).

Post-radiation: Abdominopelvic radiation used to treat a variety of malignancies, including gynecologic, prostatic, rectal, or lymphoproliferative diseases, can cause adhesions as a late sequel, the severity of which depends on the anatomic extent of the area treated, the degree of dose fractionation, and the total dose of radiation. Post-radiation adhesions can be particularly challenging to manage owing to their extent and density and the compromised nature of the underlying tissues (e.g., chronically ischemic or friable).

Peritoneal injury due to surgery, infection, or irritation is followed by an increase in vascular permeability and inflammation, with fibrinous exudate and fibrin formation, resulting in the formation of thrombin, which triggers the conversion of fibrinogen into fibrin. Under normal circumstances, fibrin bands that develop during the physiological process of healing are degraded by fibrinolysis to smaller fragments called fibrin degradation products (FDP). In contrast, a disturbance in the equilibrium between coagulation and fibrinolysis in favor of the coagulation system causes fibrin to form deposits, which act as a matrix for the growth of fibrocollagenous tissue. Fibroblasts invade the fibrin matrix and extracellular matrix (ECM) is produced and deposited ***(19).***

Symptoms of abdominal adhesive disease:

Given the firm and fibrotic nature of adhesive bands, they have the potential to interfere with normal intestinal motility and transit processes among other physiological functions. It remains unknown what proportion of patients with abdominal adhesions become symptomatic (i.e., have adhesive disease, as opposed to solely having asymptomatic adhesions) and in what proportion of such patients 'symptoms are directly due to adhesions. Symptoms attributable to adhesive disease are non-specific, and with a paucity of sensitive/accurate diagnostic tests, patients are often undiagnosed. Further complicating the symptomatology and evaluation of adhesive disease is that the location of associated abdominal pain might be referred and thus may or may not correlate with the anatomic area involved in adhesions***(21).*** In general, any of the following may be observed in association with or due to intra- abdominal adhesions:

- Chronic (persistent or intermittent) bloating.
- Abdominal cramping and borborygmi.
- Altered bowel habits, including constipation or frequent loose stools (e.g., development of small intestinal bacterial overgrowth).
- Nausea with or without early satiety.
- Bowel obstruction, which may be transient, partial, or complete

- Female infertility and dyspareunia.
- Rectal bleeding and dyschezia (i.e., painful defecation) during menses typically indicate colorectal involvement in endometriosis ***(21).***

The most serious complication of adhesions is intestinal obstruction, accounts more than 40 % of all cases of obstruction and 60-70 % of small bowel obstruction, adhesions can prevent a safe surgical entry into the abdomen and also increase the risk of hemorrhage and intestinal perforation, they can preclude adequate surgical exposure, requiring dissection that prolongs operative time, or in case of laparoscopy, hampering peritoneal insufflation ***(22).***

Assessment of peritoneal adhesions:

Preoperative planning using ultrasonography may be useful for the detection of adhesions in a previously operated abdomen. ultrasonography is designed to show spontaneous or manual compression-induced visceral slide in an effort to map the geography of dense intra peritoneal adhesions in the other hand, **Caprini et al. (23),** recommended intraoperative ultrasound to detect intra abdominal adhesions, but in fact there is no known method to assess the amount of adhesions other than visual identification during surgery. Furthermore, there is no standard classification for assessing the severity of adhesions. The Zühlke classification has been used in different studies, but it scores only the severity of adhesions and does not consider the abdominal location. The peritoneal adhesion index (PAI) has been proposed as a way to classify adhesions, according to both severity and anatomical location. However, scoring systems are not widely used. Other studies have used the amount of time spent on adhesiolysis during surgery to measure the severity of adhesions ***(6).***

Table (1): Zühlke classification for adhesion grade description *(24)*

0	No adhesions
1	Filmy adhesions, easy to separate by blunt dissection
2	Adhesions with beginning vascularization, blunt and partly sharp dissection needed
3	Adhesiolysis possible by sharp dissection only, clear vascularization
4	Adhesiolysis possible by sharp dissection only, damage of organ hardlypreventable

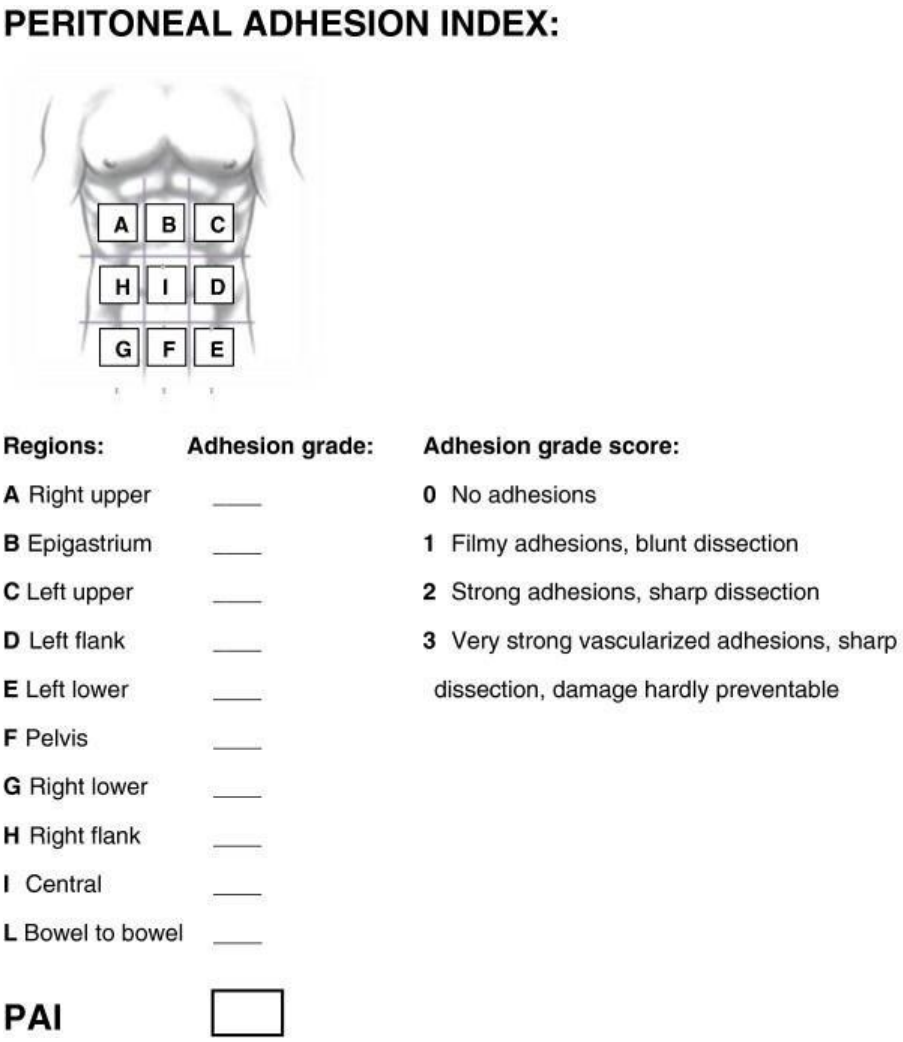

Fig. (2): Peritoneal adhesion index: by ascribing to each abdomen area an adhesionrelated score as indicated, the sum of the scores will result in the PAI.7 ***(6).***

Prevention of postoperative adhesion formation:

Some basic principles should be considered during all abdominal surgical procedures to prevent post-operative adhesion. These principles are close to the "Halstedian principles" (W.S. Halsted 1852-1922), the first surgeon who recognized the importance of these measures ***(19).***Peritoneal damage should be avoided by careful tissue handling, meticulous homeostasis, continuous irrigation, unnecessary drying, ineffective use of foreign bodies, and suturing or clamping of the tissue. The use of fine and biocompatible suture materials, atraumatic instruments, and starch-free gloves is also recommended ***(19).*** Molinas et al. have demonstrated that CO2 pneumoperitoneum increases

postoperative peritoneal adhesions in a time- and pressure-dependent relationship, and that this increase is reduced by the addition of 2%-4% oxygen, suggesting peritoneal hypoxia as the driving mechanism ***(25).*** Chemical agents generally prevent the organization of persistent fibrin byinhibiting fibroblast proliferation. Many agents are used to inhibit thisproliferation such as, non-steroidal anti-inflammatory drugs (NSAIDs), corticosteroids, calcium channel blockers, histamine antagonists, antibiotics, fibrinolytic agents, anticoagulants, antioxidants, hormones, vitamins, colchicines and selective immune suppressors. ***(26).*** Liquid or solid mechanical barriers may prevent postoperative peritoneal adhesion formation by keeping the peritoneal surfaces separate during the 5-7 days required for peritoneal re-epithelialization. Liquids, such as crystalloids, dextran, hyaluronic acid, and cross-linked hyaluronic acid, have been used to prevent adhesion. ***(19).*** Non-absorbable and bio-absorbable films, gels, and solid membranes have been applied to prevent adhesion formation. The most commonly used mechanical barriers are oxidized regenerated cellulose (Interceed®), expanded polytetrafluoroethylene (Preclude Peritoneal Membrane®), hyaluronic acid-carboxymethylcellulose (Seprafilm®), and polyethylene glycol (SprayGel®), which are non-degradable and require a second operation for removal. The most extensively studied bio-absorbable films are the Sepra film and Interceed. Sepra film is absorbed within 7 days and excreted from the body within 28 days. Prospective randomized controlled trials have shown the efficacy of Sepra films in reducing the incidence and extent of postoperative adhesions. However, Sepra film may cause significant impairment of anastomosis and should not be used in anastomosis cases. ***(27).***

Conversion to open cholecystectomy:

An important issue for surgeons performing a laparoscopic cholecystectomy is whether and when the procedure should be converted to open cholecystectomy. ***(28).***In the following situations, a low threshold for conversion to open procedure should be maintained.

- Dense adhesion in Calot's triangle
- Excessive bleeding is encountered
- Patient anatomy is unclear
- Multiple vessels are seen entering the "gallbladder," or a very large cystic duct is seen (especially if it is normal on ultrasonography), suggesting that the surgeon may be in the wrong place.

Conversion to an open procedure should not be considered a complication, and the possibility that it will prove necessary or advisable should be discussed preoperatively with the patient. In most cases, the conversion rates are higher for emergency operations. Reported rates range from 1.5% to 15%, with most studies reporting rates around 5% for elective cases.***(29).*** Multivariate analysis identified male sex, elevated white blood cell

count, low serum albumin level, pericholecystic fluid noted on U/S, diabetes mellitus, and elevated total bilirubin level as independent predictors of conversion. Another multivariate analysis identified male sex, positive Murphy' s sign, gallbladder wall thickness exceeding 4 mm, and previous upper abdominal surgery as independent predictors of conversion to an open procedure ***(30).***

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