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Laparoscopic cholecystectomy: early and late complications and their treatment

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Abstract *Summary:* Laparoscopic cholecystectomy gained wide acceptance as treatment of choice for gallstone disease and cholecystitis. With this new technique, not only did the new era of minimal invasive surgery begin, but also the spectrum of complications changed. Laparoscopy-related complications such as access injuries and procedure-related problems are discussed in our article. Typical mishaps are reviewed according to the literature. Set-up of the pneumoperitoneum (morbidity up to 0.2%); bleeding—from trocar sites and vascular injury (mortality up to 0.2%); biliary leaks and bile duct injuries are the main topics in this article (still on a level of 0.2%–0.8%). Aetiology, diagnosis and treatment are discussed, and an overview of the most cited classifications of bile duct injuries is summarised graphically. Finally, bowel injuries as a specific complication in laparoscopy are discussed (incidence up to 0.87%). *Conclusion:* Careful selection of patients, the knowledge of typical procedure-related complications, and their best treatment are the key points for a safe laparosopic cholecystectomy.

Keywords Laparoscopy · Complication · Laparoscopic cholecystectomy · Bile duct injury

Introduction

Laparoscopic cholecystectomy (LC) has replaced open surgery in the treatment of symptomatic cholecystolithiasis. Gallstone disease has a great impact on a surgeon's daily routine. In the USA approximately 1 million patients are newly diagnosed annually, and approximately 600,000 operations are performed a year [1], more than 75% of them by laparoscopy [2, 3]. The new technique offers the patient the advantages of minimal invasive surgery (MIS), which has been reported in many series over the past 15 years [4, 5]. However, with the widespread acceptance of this operation all over the world, the spectrum of complications in gallstone surgery has changed: typical MIS-related complications such as vascular and bowel injuries, complications adjusted with the instillation of the pneumoperitoneum, as well as procedure-related complications, have raised morbidity to 2.9% [6, 7]. The spectrum of mishaps has also changed, due to the involvement of new instruments [8], such as stapling devices, coagulation shears and sealing systems. Related complications like migrating clips [9] or stenosis of the common bile duct (CBD) due to a wrongly placed clip were completely unknown in open surgery. From the old controversial discussions, such as the need for an intraoperative cholangiography or the treatment of common bile duct stones (CBDS), new aspects have emerged. In this article typical operation-related complications are reviewed according to the available literature.

Pneumoperitoneum

The creation of the pneumoperitoneum itself has a mortality risk of up to 0.2% [10]. The incidence of injuries from trocars or Veress needles is also up to 0.2% [11, 12]; injuries during set-up of the pneumoperitoneum are responsible for 50% of all complications during laparos-

copy [12]. The opinions on how to start a laparoscopic procedure vary from the open "Hasson" technique, which was first described in 1971 [13], to reports of no advantage of the open technique [14]. However, the closed approach is more popular [15], though two randomised trials could not show any timesaving advantages [16, 17]. This is quite astonishing, with regard to the literature, because most of the recent articles show evidence that the Veress needle has a higher risk of causing an injury than the open technique has [18]. Yerdel et al. report in their study, which included 1,500 patients who had undergone LC, a 14% rate of injury with the needle technique vs 0.9% with the open technique [19]. In an Italian multicentre trial the incidence of injury with the needle was 0.18% vs 0.09% with the open technique [15]. The choice of the trocar itself seems to be less responsible for complications [11].

Bleeding

Bleeding from trocar sites and vascular injury

The major problem in discussing vascular injuries is that there is no systemic classification. What is major bleeding, what is minor bleeding? Such complications are usually summarised as trocar injuries, and there might be a high rate of unpublished data [20].

Two-thirds of external bleeding is seen postoperatively, after the pneumoperitoneum has been decreased, and most incidents require surgical intervention. However, diaphanoscopy during the insertion of the trocars, and meticulous observation of the skin incision after removal of the trocar, for at least 20 s, might reduce the risk of a bleeding complication.

The incidence of major vascular injuries in laparoscopy (including aorta, iliac vessels, vena cava, inferior mesenteric arteries and lumbar arteries) is 0.07%–0.4%, and for minor injuries (branches of the epigastric vessels, mesenteric and omental vessels) is 0.1%–1.2% [15]. The mortality rate is 0.05%–0.2% [10]. This leads to the highly debatable topic of how the pneumoperitoneum should be set up, which is not really a topic for our paper.

Bleeding from the liver bed

Only few data are available on the real incidence of bleeding complications from the liver. In the meta-analysis from Shea 163 patients out of 15,596 that suffered bleeding required conversion (8%) [21]. In a paper from the Swiss Association of Laparoscopic and Thoracoscopic Surgery, which included general laparoscopic procedures, in 287 out of 14,243 patients severe intra-abdominal bleeding, including vascular injuries, was observed. Two patients died after bleeding from the liver bed.

Bleeding from the liver is mainly a situation in cirrhotic patients. These patients have often been classified as showing a contraindication for LC [22]. However, recent data have proved LC to be safe in expert hands. Yeh et al. demonstrated, in their single-centre trial that compared LC in cirrhotic and non-cirrhotic patients, the same rate of blood loss, conversion rate (4.4% vs 4.6%) and morbidity rate (6.6% vs 5.3%). Only mortality was different: two patients (0.88%) in the LC died postoperatively but not due to a bleeding complication [23]. Recently, a meta-analysis that included 25 publications and 400 patients was published and demonstrated a significantly higher bleeding rate in cirrhotic patients (26% vs 3.1%) and a significantly higher morbidity rate(20.86% vs 7.99%) [24]. Nonetheless, in our analysis, which compares LC with open cholecystectomy (OC) in cirrhotic patients, there is a definitive advantage to LC. However, in the hand of experienced surgeons LC might also be a saving procedure in cirrhotic patients. Morino et al. showed in their series that such operations can be undertaken without mortality and without morbidity [25]. The main goal of LC for patients in whom the situation is difficult is to have the policy of a low threshold for conversion.

Biliary complications

Spilled gallstone

Spillage of gallstones is a common problem during LC. Its incidence is estimated between 10% and 30% [26, 27]. This is higher than during OC [28, 29]. Two main factors are predictive for the mishap of a gallstone spillage: the surgeon's experience in LC and the degree of inflammation [30]. However, most of the spilled stones do not cause symptoms. If they do, the time gap between the operation and the first clinical signs is usually wide, between immediately and 29 months postoperatively, with a peak after 4 months [31]. In a retrospective analysis from Switzerland only 1.4% of patients with spillage of gallstones during LC developed serious postoperative complications [32]. Horton and Florence reported that 5% of their patients showed symptoms [33]. Risk factors for the occurrence of symptoms after spillage are the stones' chemical composition and the presence of acute gallbladder inflammation or infected bile. Pigmented stones usually promote the genesis of abscesses more than the others do [34, 35]. Stones might be lost in the abdominal cavity, due to gallbladder perforation during the dissection, or in the abdominal wall during extraction of the gallbladder [36]. Secondary complications due to spilled gallstones are various. The most frequent one is intra-abdominal abscess formation followed by abdominal wall infection or permanent sinus [36]. Some other serious complications reported in the literature are small bowel

obstruction [37], incarceration in a hernia sac [38] and trans-diaphragmal migration that results in pleural empyema or expectoration of bile and pus [39]. Stevens et al. reported one case of spillage that caused dysmenorrhoea, resulting in a hysterectomy [40].

The diagnosis is made with the synopsis of the patient's history, the operation protocol and a CT scan. Therefore, it is necessary for the patient to be informed if any stone was left in the abdominal cavity. The treatment depends on the clinical and radiological findings. Percutaneous drainage and antibiotic treatment might be considerable [41]; however, surgical treatment, including stone retrieval and abscess evacuation, will be the most valuable tool that provides a definitive solution. For prevention of such complications, every spilled gallstone should be removed, and the abdominal cavity rinsed with saline solution in case of gallbladder perforation. Because of the low morbidity of spilled gallstones, conversion to open procedure seems not to be justified [32].

Biliary leaks

Biliary leaks are easily diagnosed if a subhepatic drain is placed routinely after LC, but there is no evidence to suggest that a drain should be placed routinely. However, whenever the postoperative course is uncommon and recovery is delayed, an intra-abdominal complication should be suspected [42, 43]. Ultrasound, CT scan, MRCP and finally ERCP and PTC will identify the complication and its location [44, 45]. The management of such a complication requires an interdisciplinary team that includes an experienced endoscopist, radiologist and surgeon.

Cystic duct insufficiency, small or punctiform lesions, and aberrant open bile ducts are usually best treated endoscopically, either by nasobiliary stenting or by the employment of a stent by ERCP [7, 46]. Additionally, a drain might be placed sonographically or under CT guidance in case of a bilioma [47, 48]. Early re-laparoscopy provides the possibility for closure of the cystic stump or leak and a lavage. In case of diffuse peritonitis open surgery is suggested [49].

Bile duct injury

Undoubtedly the most frequently reported complication is common bile duct injury (CBDI).

Incidence. Results from OC indicate a CBDI incidence of 0.125%–0.25% [50–56]. After the introduction of LC, early series reported a high increase of CBDI, up to 2% [57–59] and 4% in acute cholecystitis [60]. This was interpreted as an effect of the "learning curve" [61, 62]. Later on, the incidence balanced out at between 0.2% and 0.8%, which is still higher than in open surgery [63–67]. The truth of the story of the learning curve is not yet proven. While some authors report a dramatic decrease in incidence after 50 or 100 LCs have been carried out [50, 61, 68], Morgenstern et al. in their report found no difference in the incidence of CBDI between the first and the second series of 1,500 LCs [69]. Moore and Bennett report a "plateau", which is reached after 30 LCs have been performed [50]. Targarona et al. reported the highest incidence by surgeons who had done more than 50 operations [8], whereas Gigot et al. report from the Belgian multicentre trial that the incidence performed by surgeons who have undertaken fewer than 50 LCs is 1.3% [70].

Mechanism. New access, as well as new instruments and technique, have changed the mechanism of injury compared to OC. Laparoscopic injuries seem to be more severe and, on average, more central to the liver [71–73]. Slater et al., in their retrospective analysis that compared OC with LC, found 31% severe injuries in the LC group, according to the Strasberg classification, in comparison with 12% during OC [74]. Recent reports about the management and outcome of CBDI indicated a coincidence with vascular injuries. Buell et al. reported combined injuries of up to 27% [75].

The typical or classic injury is the defect lesion of the CBD. A part of the CBD is resected because of a misidentification of the cystic duct [76, 77]. This mishap usually occurs because of too much antero-lateral traction of the gallbladder infundibulum, which results in a so-called lateral T.

A difficult pathological condition such as a Mirizzi syndrome might need sharp dissection in Calot's Triangle, resulting in partial lesions of the CBD or right hepatic duct. This injury could remain undetected if a routine IOC is not performed. Bile leaks might occur due to clip displacement, necrosis of the cystic duct due to the clip or aberrant ducts [78, 79]. Excessive electrocautery, as well as radical and traumatic dissection along the CBD, are discussed as reasons for late postoperative strictures. Male gender seems not to be a risk factor for a CBDI in LC [80].

Classification of CBD injuries

Dealing with biliary tract injuries requires a systemic classification. In the prelaparoscopic area, injuries have usually been classified according to the Bismuth classification [81]. After the introduction of LC several systems and classifications have been proposed. They are all more or less specific or detailed, and it is difficult to choose one as the best. The Bismuth classification is created for the description of postoperative strictures but lacks some details for the recording of acute defect lesions. However, it is still one of the most used systems, even in the latest reports [59, 82, 83]. The Strasberg system is very spe-

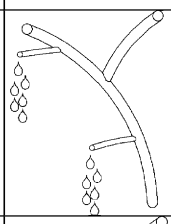
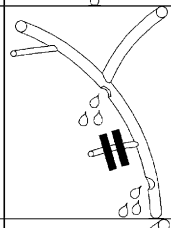
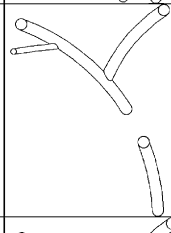
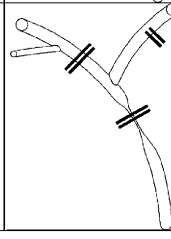
Siewert [96]	Neuhaus [85]		McMahon [113]	Strasberg [73]
I	A		Minor	A, B
III	C		Minor	C, D
IV	D		Major	E1, E2, E3, E5
II	B1-2 E1-4		Major	E4

Fig. 1 Schematic presentation of the four most cited classifications of bile duct lesions. *First line:* minor lesions such as cystic duct insufficiency, or partial/tangential opening of peripheral ducts (Luschka), partial CBD lesion <25% of diameter, leakage from the liver bed. *Second line:* tangential lesion of the CBD (with or without arterial component) divided right segmental duct, lateral injury common hepatic duct. *Third line:* defect lesion of the CBD (with or without arterial component), CBD lesion >25% of diameter, common hepatic duct division less than or more than 2 cm from bifurcation, division at bifurcation. *Fourth line:* late postoperative stricture, isolated left or right hepatic duct stricture, lesion of the CBD, occlusion of the CBD

cialised for frequent and less frequent injuries but is not as practicable as the McMahon system, which is easy to remember and to use in the daily routine. Very clearly arranged is the Siewert classification, which concludes with the most important types of injuries in four practicable groups that include vascular injuries, which is the major difference from the Amsterdam criteria [84]. Recently, Neuhaus et al. presented a new classification that included clinical, aetiological and therapeutic aspects [85]. The most cited classifications are graphically summarised in Fig. 1.

Diagnosis and management

Most of the lesions are diagnosed postoperatively, in LC usually later than in OC [8, 86]. In one of the first major multicentre trials Woods et al. reported approximately 37% of injuries diagnosed intra-operatively when an IOC was not performed. Walsh, Lillemoe and Chaudhary and their co-workers had 29%–30% intra-operatively diagnosed lesions in their series [72, 83, 87], while Richardson stated that less than 50% are diagnosed intra-operatively [3]. However, this is a major problem in the management of bile duct injuries because it is a matter of fact that, beside the surgeons experience [88], early diagnosis improves the results [63, 89]. The primary repair done by an experienced surgeon will provide the best results [90].

This leads to the highly debatable topic of intra-operative cholangiography. The opinion is split between routine use [2, 73, 91], to prevent CBDI, and selective use [92]. However, biliary complications might be earlier and more frequently detected with routine intra-operative cholangiography [93, 44]. Therefore, the possibility of IOC should be available 24 h a day in each place where biliary surgery is performed, and young surgeons should be trained in the correct interpretation of IOC. Berci claims that only surgeons who know how to interpret an IOC should perform a LC [94].

As previously stated, the repair should be done by an experienced surgeon. This implies that patients operated on in low-volume centres with less biliary surgery should be transferred to a biliary centre [57]. It seems that biliary complications in laparoscopic surgery are less frequently referred than in OC; too many patients who were suffering from biliary tract complications after surgery had the first attempt at repair carried out in the same institution as where the injury occurred [83, 45].

A defect lesion of the CBD, type IV, according to Siewert, requires a biliodigestive anastomosis (Roux-en-Y) [59, 95, 96, 77, 82, 85, 97]. Heistermann et al. investigated the feasibility of an autologous vein graft and a biodegradable stent for the treatment of a defect lesion in an animal model with success, but there are no clinical results at this time [98]. A dissection of the CBD, without resection, might be sutured if a tension-free suture is feasible, after insertion of a T-tube drain [96] aside of the anastomosis. This “classic injury” often has a concomitant vascular injury, which might have a major impact on the post-repair course. Buell and colleagues had an incidence of 63% at level III and 71% at level IV [75]. That is why some authors recommend searching for such an injury in the case of a severe CBDI [82]. The incidence of a vascular injury in cases of defect lesions of the CBD is approximately 7% in OC [99] and up to 41% in LC [100, 101]. This might be due to the vascular anatomy: approximately 30% of the right hepatic arteries cross anterior to the CBD [102]. How a combined vascular and bile duct injury should be managed is not yet clearly defined.

Data from open cholecystectomy gave satisfactory results when the artery had been identified and ligated [99, 103]. Gupta and Schmidt and their co-workers recommend in their papers, in cases of early recognition, the primary repair of both artery and bile duct to prevent postoperative necrosis, fistulas and possible strictures [82, 104]. Buell et al. demand an angiography prior to reconstruction [75].

Late postoperative strictures

Late postoperative strictures are usually the result of biliary reconstruction for injuries after cholecystectomy or excessive use of electrocautery near the CBD [105]. Several treatment options can be discussed. Primarily, an anatomical map, via MRCP, percutaneous cholangiography or ERCP, should be achieved. Percutaneous balloon dilatation might be feasible, but the results are poor [79, 106]. Biliary stenting has also been suggested [107]; however, Chapman and co-workers suggests that these methods be reserved for patients who are not able to undergo re-surgery [59]. Postoperative strictures most probably require a biliodigestive anastomosis with a Hepp Couinaud approach [59, 108]. A modification for permanent biliary access was presented by Krige et al. They suggest that the end of the Roux-en-Y loop be fixed to the anterior abdominal wall [109].

Bowel injury

Bowel injuries most probably occur during the insertion of the trocars, seldom during dissection or adhesiolysis. They often remain undetected during the operation. The incidence in our unit is 0.07%–0.7% [110], Bishoff reported 0.87% during laparoscopic urological procedures [111]. In the nationwide survey of the Swiss group 19 visceral organ injuries are reported among 14,243 laparoscopic procedure [18]. Bowel injuries can be avoided: control of the integrity of the isolation of the instruments, no out-of-sight activities, and trocar placement under direct vision.

Conclusion

LC is one of the most frequently performed laparoscopic operations [112]. The new technique rapidly gained wide acceptance and has a low rate of mortality and morbidity. However, MIS of the gallbladder is connected with complications related to the new technique and to the operation. Most of the mishaps mentioned above are due to lack of experience or knowledge of the typical errors. A rational selection of patients, as well as a low threshold for conversion, in combination with adequate training, makes this operation a safe procedure.

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