World J. Surg. 29, 987–993 (2005)
DOI: 10.1007/s00268-005-7871-4

WORLD Journal of SURGERY
© 2005 by the Société Internationale de Chirurgie

Bile Duct Injuries at Laparoscopic Cholecystectomy: A Single-Institution Prospective Study. Acute Cholecystitis Indicates an Increased Risk

Claes Söderlund, M.D, Ph.D., Farshad Frozanpor, M.D., Stefan Linder, M.D.

Upper GI Surgery Section, Department of Surgery, Stockholm South Hospital, SE 118 83 Stockholm, Sweden

Published Online: June 30, 2005

Abstract. During the last decade laparoscopic cholecystectomy (LC) has become established as the gold standard. The drawbacks in the form of bile duct (BD) injuries have also come into focus. We present the results of a prospective, consecutive series of 1568 patients with reference to BD injuries regarding risks, management, and preventive measures. The significant complications of all patients operated upon with LC between October 1999 and December 2003 were recorded prospectively. BD injuries were classified according to Strasberg into types A–E. Transected major BDs, injuries of type E, were regarded as "major" injuries and types A, B, C, and D were "minor" injuries. Major BDs were transected in five patients (0.3%), three of whom had acute cholecystitis. In the two patients operated on electively, the BD injuries were detected postoperatively, while they were detected intraoperatively when the operation was performed of necessity. The BDs were all reconstructed with a Roux-en-Y hepaticojejunostomy. Two patients had anastomotic strictures. Minor BD injuries were encountered in 19 patients (1.2%). The 13 patients with leakage from the cystic duct or gallbladder bed, injury type A, were treated by endoscopic (ERC) stenting without sequelae. Five patients sustained a lateral BD injury, type D; they were treated with a simple suture over a T-tube (at LC) or endoscopically (ERC) without further problems. A transected aberrant right hepatic BD, type C injury, was due to its small-caliber sutured. Minor BD injuries could be managed at the primary hospital if the endoscopic expertise were at hand. Acute cholecystitis seems to be a risk factor for BD injuries.

Laparoscopic cholecystectomy (LC) was widely adopted in the early 1990s and has become the standard operation for both elective and acute cholecystectomy [1]. Much attention has been given to complications of LC since its introduction. In a series of open cholecystectomies (OC), serious complications occurred in approximately 0.1%–0.5% of the patients [2–5], while this frequency is usually doubled in a series of laparoscopic operations, 0.3%–1% [6–8]. Postoperative bile leakage is sometimes the result of the most serious adverse event at cholecystectomy, bile duct (BD) injury. Major injuries are usually transections or other extensive damage to the BDs. Although BD injuries appear to be more frequent after the introduction of LC, there is some evidence that at least the number of minor injuries has not increased, i.e., bile leakage from the cystic duct stump or the gallbladder (GB) liver bed [1]. Early operation has been advocated in acute cholecystitis. There is some controversy as to whether cholecystitis is a risk factor [6–8]. Since 1999 we have prospectively recorded complications and side effects in our 1568 consecutive elective and acute LCS. This presentation is focused on BD injuries at LC; the risks, the reparative procedures, and measures to prevent BD injuries are discussed.

Correspondence to: Claes Söderlund, M.D, Ph.D., e-mail: claes.soderlund@sodersjukhuset.se

Patients and Methods

LC was introduced at the Department of Surgery, Stockholm South Hospital, in 1991. During the period from October 1999 to December 2003, 1568 patients (61% females and 39% males) were operated on with LC in our department of upper GI surgery. Among the 1218 (77.7%) patients who had the operation electively, 68 (5.6%) were converted to the open operation. Indications for conversion were anatomic difficulties (usually a result of acute or chronic cholecystititis), difficulties in dissecting the GB from the liver bed, bleeding not controlled by laparoscopic measures, and suspicion of a BD injury and/or bile leakage (besides from, the GB).Three hundred fifty (22.3%) patients had LC urgently for acute cholecystitis, the conversion rate being 31 of 350 (8.9%). "Acute cholecystitis" was defined as an ongoing attack of biliary pain, not subsiding within 12 hours, associated with fever and leukocytosis, and ultrasonographic evidence of acute inflammation. These patients were admitted as emergencies and scheduled for an urgent daytime operation. In 999 (82%) of our elective patients, short-stay (overnight) surgery could be performed.

One thousand two hundred forty-six (79.5%) of the patients were in the age group 20–59 years and 314 (20%) were 60 years old or older. The median followup was 27 months (range, 10–60 months). Complications related to the surgical procedure were included prospectively in a complication data file, which is the basis of this report. "Major" BD injuries were defined as a transected major BD (or an incision comprising more than 50% of the circumference or similar extensive damage), i.e., type E according to Strasberg [1]. All other injuries were classified as "minor" (types A–D), e.g., leakage from the cystic duct or hepatic GB bed, type A (Table 1).

Table 1. Bile duct injuries in 24 of 1563 patients (1.5%) according to the classification of Strasberg

Strasberg group	Definition	Patients
A	Leak from the GB liver bed or cystic duct	13
B	Occlusion of part of the biliary tree	0
C	Leak from duct not in communication with CBD (usually transection of aberrant right hepatic duct)	1
D	Lateral injury to extrahepatic BDs	5
E_1	Transection >2 cm from hilum	2
E_2	Transection <2 cm from hilum	2
E_3	Transection in the hilum	1
E_4	Separation of major ducts in the hilum	0
E_5	Injury type C + injury in the hilum	0

We have performed LC using the standard four-porttechnique (two 10-mm ports and two 5-mm ports) after the introduction of pneumoperitoneum with a Verres needle. Intraoperative cholangiography (IOC) was not used routinely, but only when we suspected BD stones or in case of anatomic difficulties during dissection. IOC was performed in 177 patients (11.3%). BD stones found at IOC were treated with a Suigura flat-wire-type stone basket (Wilson-Cook®) passed through the cystic duct under fluoroscopy or, in case of failure, with intraoperative endoscopic retrograde cholangiopancreatography (ERCP).

The dissection of the GB, especially at the triangle of Calot, was standardized according to the French "flag" technique [9–11], i.e., a grasper in the GB pouch was used to produce a lateral-caudal traction to pull away the cystic duct from the common bile duct (CBD) at a 90° angle. Furthermore, the peritonium, cranial to and inferior to the distal part of the GB at its liver bed, was first incised and dissected close to the GB, as well as the lower part of the GB, before any attempt was made to dissect the cystic duct or cystic artery. In this manner, the GB will finally be attached to the CBD at its lower part only by the cystic duct and artery. Thus, the anatomy was clarified to avoid damage to the CBD or common hepatic duct (CHD). The cystic duct and artery were cut and the GB was subsequently dissected from, the liver by cautery. Most (75%) LCs were performed by one of the four staff surgeons with experience of at least 300 LCs each. Surgeons in training performed the rest with assistance from the experienced surgeons.

The biliary reconstruction of transected BDs (type E injuries) was performed by one of two experienced HPB surgeons who were not involved in causing the injuries. End-to-side hepaticojejunostomy was used with a Roux-en-Y loop at least 40 cm long, carefully avoiding tension. After excision of any scar tissue, a mucosa-to-mucosa one-layer anastomosis was created with absorbable 4-0 suture material using the interruped technique. The anterior suture row was first placed at the BD with the needles kept in place and with cranial traction in order to then be able to suture the posterior side of the anastomosis more easily. Finally, the anterior row was completed. The sutures were always kept on clamps and untied until completion of the entire suture row. Anastomotic splinting with a T-tube was used for drainage and postoperative cholangiographic followup. The injury was always investigated by direct intra- or postoperative cholangiography before any attempt to repair. Angiography was not performed.

Fisher's exact test was used to analyze differences in the distribution of absolute numbers of patients.

Results

We encountered BD injuries in 24 of the 1568 (1.5%) LC patients (Table 1). Fifteen of these patients had concomitant acute cholecystitis ($p = 0.041$). There were 5 major and 19 minor BD injuries. The classification of the BD injuries according to Strasberg [1] is presented in Table 1. The mortality was 1 of 1568 patients (0.06%). This patient, operated upon electively, expired from diffuse bleeding related to anticoagulant therapy.

Five patients (0.3%) sustained major BD injuries, with a completely transected CHD or CBD, Bismuth–Strasberg class E_1–E_3 [1] (Table 2, Figs. 1 and 2). To the best of our knowledge, these injuries were mainly caused by sharp dissection (not cautery). Acute cholecystitis was present in three of these cases ($p = 0.077$). All the patients with a type E injury underwent reconstruction with a Roux-en-Y hepaticoenteric anastomosis (Fig. 2C). In three of the major BD injury patients, all with acute cholecystitis, the damage was discovered at the initial operation and was confirmed by intraoperative endoscopic retrograde cholangiography (ERC) or IOC (cases 2, 4, and 5, Table 2) before reconstruction during that same session. The other two patients, both operated on electively (cases 1 and 3, Table 2), were reoperated upon on the 2nd and 13th postoperative day, respectively ($p = 0.100$). They were both drained preoperatively by percutaneous transhepatic cholangiography (PTC) and ultrasound (US)-assisted (subhepatic) catheter insertion. Two patients still have sequelae after their major BD injury (cases 3 and 5, Table 2). One of these patients (case 5) now has a complete and the other (case 3) a relative obstruction of the BD-enteric anastomosis (Fig. 2).

Minor BD injuries were encountered in 19 patients (1.2%), types A, C, or D according to Strasberg [1] (Table 3, Fig. 3). Acute cholecystitis was present in six cases ($p = 0.403$). There were 10 patients with cystic duct leakage, all treated successfully by endoscopic stenting (Fig. 3). Bile leakage from the liver bed was drained percutaneously in one patient and was treated with an endoscopic endoprosthesis (EP) in two cases. There were also five lateral BD injuries. These type D injuries were caused by cautery/clips (one patient, Fig. 4), cutting with scissors (two patients), and perforations from a transcystic stone basket (two patients). The two cases with small incisions were repaired with primary suturing over a T-tube at the initial (converted) operation without further problems. One patient was readmitted five weeks after LC with jaundice caused by a short CHD stricture (Fig. 4). The stricture was probably caused by a compromised blood supply secondary to cautery/clips. The patient was treated endoscopically with dilatations and EP and has had no sequelae during two years of follow-up. One patient had a type C injury [1] with a segment VI/VII aberrant BD transected. After conversion we considered such a small-caliber duct (2 mm) difficult to reconstruct and it was sutured. Postoperative ERC and magnetic resonance cholangiopancreatography (MRCP) confirmed the intraoperative findings. This patient has had normal liver function tests and is without symptoms one year and three months later. None of the 19 patients with minor BD injuries have any persisting sequelae. We discovered no patients with type B injuries.

Twenty-three patients (1.5%) suffered from bile leaks. The bile leak was detected during the operation in six patients: three patients with a major injury type E (cases 2, 4, and 5) (Table 2), two patients with type D injuries, and are patient with the type C

Table 2. Major bile duct (BD) injuries were encountered in 5 of 1563 patients (0.3%) undergoing laparoscopic cholecystectomy

Patient No. /age/gender Setting	Followup (months)	Injury type	Perioperative investigation	Type Repair[a] Time[b]	Postoperative Investigation	Current symptom	Comment
1,30 y, f Elective	48	E_2 CHD	MRCP US+drain ERCP IOC (at repair)	R T-tube 13 d	T-tube chol. MRCP × 2	None	Difficult repair Hilar Narrow BD
2, 67 y, m Acute	42	E_2 CHD	IOC (at repair)	R T-tube 0 d	T-tube chol. MRCP × 4	None	Difficult repair Hilar
3, 53 y, f Elective	38	E_1 CBD	ERCP PTC PTCD	R T-tube 2d	T-tube chol. MRCP × 3	Cholangitis	Technically easy repair Moderate stricture
4, 55 y, m Acute	18	E_1 CBD	ERCP	R T-tube 0 d	T-tube chol. MRCP	None	Technically easy repair
5, 65 y, m Acute	13	E_3 CHD	ERCP	R T-tube 0 d	T-tube chol. MRCP × 5PTC × Percutaneous cholangioscopy	Cholangitis	Difficult repair Hilar Narrow BD Tight stricture PTBD

IOC-intraoperative cholangiogram, PTBD-percutaneous transhepatic biliary drainage, CHD-common Hepatic duct, CBD-Common bile duct, MRCP-magnetic resonance cholangiopancreatography.

[a]R-Roux-en Y hepaticojejunostomy.

[b]Days after BD injury.

CPercutaneous cholangioscopy through the PTC tract.

injury. Seventeen patients had postoperatively detected leaks: two patients with a major injury type E, all 13 cases with a minor injury type A (Fig. 3), and two patients with type D leaks after perforation of the CBD secondary to transcystic stone basket exploration. Thus, bile leaks found intraoperatively tended to be associated with a major BD injury, although not statistically significant ($p = 0.089$).

Discussion

Historically, surgeons have been well aware of the tragedies of major bile duct injuries after cholecystectomy. In a large Swedish series from the 1950s that included 237 patients, one-third died within two years [12]. Even in a more recent review there is still considerable mortality (31% in high strictures) as reported by Moossa et al. [13].

This article describes a consecutive series of 1568 LC patients operated on in our institution over 4 years and 3 months starting in October 1999. It is evident that multidisciplinary action is necessary, i.e., to have a radiology department experienced in PTC (Fig. 2B), US-assisted percutaneous drainage, and MRCP (Figs. 1A, B, 2C). ERCP is a key instrument in investigating suspected BD injuries (Fig. 1–4). The intraoperative ERCP approach is valuable for both delineating the biliary anatomy and treating CBD stones. In the absence of important facilities for investigation and treatment, including the technical skills for performing a tension-free mucosa-to-mucosa anastomosis of adequate diameter and treating a difficult stenosis by ERCP (Fig. 4) and/or PTC, it is recommended to refer the patient to an experienced center [1].

When BD injuries are reported, type A leaks (Fig. 3) are often omitted since they seldom pose a long-term problem [1]. Whether types C and D (Table 1) should be included with the major type E BD injuries can be disputed, late strictures may appear as a rule within the first year after LC [1, 11, 14]. In the present study the frequency of major BD injuries (0.3%) was comparable with that in other series; 0.5% major BD injuries were found by Strasberg and Soper [1] on analyzing 124,000 LCs and by MacFadyen et al. [6] in a series of 114,000 patients. There is, however, a strong tendency to underreport injuries, especially in reports from single institutions [15]. Thus, reports of biliary injuries and after LC must be interpreted with caution, as discussed by Strasberg and Soper [1] and Lillemoe [11]. The most accurate data come from surveys that include thousands of patients and different types of hospitals [1–4, 6–8]. In Sweden, every hospital has its own catchment area, implying that a patient with a post-LC injury, if already discharged from the hospital, will be referred back to the same hospital. Moreover, all patients in this report were treated on the same ward, and the records of all patients remaining in hospital for more than 36 hours (18%), as well as those readmitted, were scrutinized for significant complications. Thus, we have reason to believe that all BD injuries came to our knowledge if diagnosed within our median 27 months (range, 10–60 months) of follow-up. However, we found no type B injuries, i.e., occlusion of part of the biliary free (Table 1). It is possible that the follow-up was too short to rule out this type of injury which is often related to a compromised blood supply.

In the present series bile leakage was found in 23 patients. As in many other series, the leaks were often detected postoperatively (73%) [1, 9, 16–19]. The majority of these cases involved

Fig. 1. (**A–D**). Type E_2 injury, case 1 (Table 2). (**A**) Preoperative MRCP showing a narrow hepaticocholedochus and a GB with stones. Note the aberrant right hepatic duct (arrow). Thick arrow is pointing at the confluence of the hepatic BDs. (**B**) Post-LC MRCP showing bile leak from a transected common hepatic duct (arrow). Note the exceptionally slender intrahepatic ducts. (**C**) Post-LC ERC showing a bile leak and clips (arrow) from the LC in the region of the cystic duct. No contrast filling of the proximal bile tree. (**D**) Reconstruction with a Roux-en-Y hepaticojejunostomy over a T-tube entering the left hepatic duct.

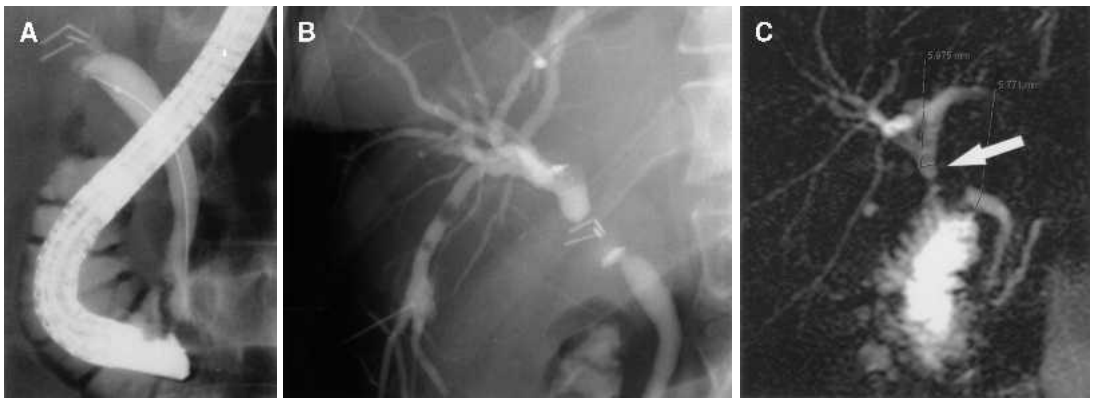

Fig. 2. (**A–C**). Type E_1 injury, case 3 (Table 2). (A) ERC showing a transected BD with clips but no contrast filling of the intrahepatic BDs.(**B**) The situation fully disclosed by PTC: a severed hepaticocholedochus with clips at both ends. (**C**) MRCP after 34 months showing a relative stricture at the hepaticojejunostomy (arrow).

minor BD injuries [1, 6]. In our study 15 of 17 postoperative leaks were caused by minor injuries (13 type A cystic duct or GB bed leakages and two patients with a stone-basket perforation). Two patients sustained serious circumferential damage to a major BD (cases 1 and 3, Table 2). It is important to recognize the characteristic symptoms of this injury postoperatively; there will be more pain than usual, a slight elevation of liver function tests, and tenderness on palpation of the abdomen subcostally to the right or generally. Jaundice is usually not present, but a subhepatic fluid collection is found on US. It is then preferable to have a

Table 3. Minor bile duct (BD) injuries were encountered in 19 of 1563 patients (1.2%) undergoing laparoscopic cholecystectomy

Type of injury Strasberg [1] type	Patients	Acute operation	Conversion	Treatment
Cystic duct Leakage, A	10	6	2	ERC + stent; 10 percutaneous US drain; 4 ERC + stones ex; 2
Liver bed Leakage, A	3	1	0	Percutaneous US drain; 1 ERC + stent; 2
Lateral BD Injury, D	5	1	3	ERC + stent; 2 Op. sut. + T-tube; 2 relap. + sut.; 1
Aberrant duct Injury, C	1	0	1	Op. sut.; 1

Op. Sut. = operative suture, ERC = endoscopic retrograde cholangiography, relap. + sut. = relaparoscopy + suture

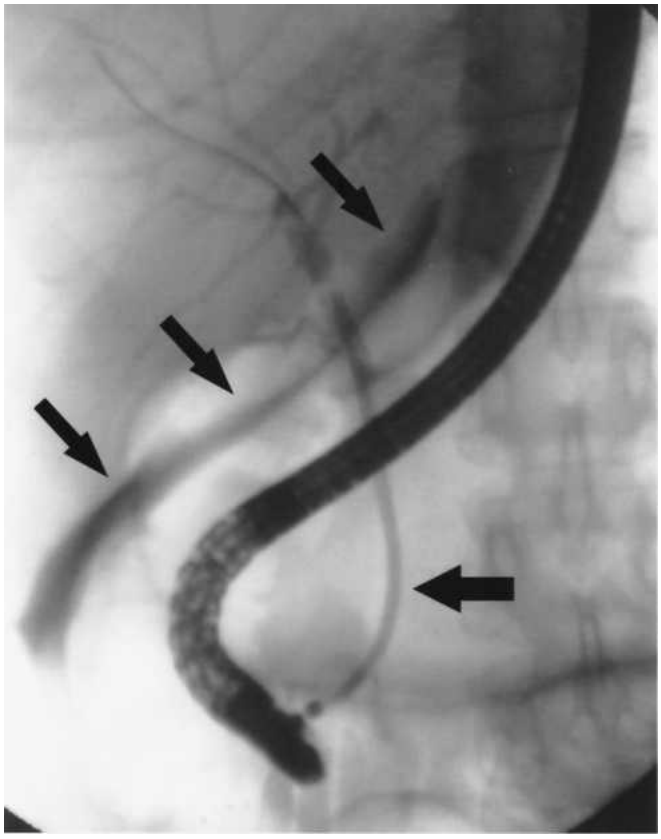

Fig. 3. Type A injury, ERC. Leakage of contrast dye at the level of the cystic duct (arrows). Treated by a stent (thick arrow).

percutaneously placed drain to confirm bile leakage at the same time. The threshold for ERC must be low when this type of injury is suspected. An endoscopically placed EP will cure this patient quickly (with or without sphincterotomy), as in our cases, almost without exception [9, 16] (Fig. 3).

Contrary to postoperative leaks, an unexpected intraoperatively detected bile flow is often caused by a major BD injury and should he a strong warning sign to perform IOC and to consider conversion to an open operation [1, 20–24]. In our series, three of six intraoperative bile leaks were caused by a major BD injury.

Five patients had type D injuries [1], two of them involving perforations caused by a stone basket during transcystic CBD exploration. In another two patients, incisions or injuries to less than 50% of the diameter of the BD were detected intraoperatively and readily repaired over T-tubes, which is in accord with the experience reported in the literature [1, 10, 13, 14]. One patient presented with a short CHD stricture probably related to cautery 1.5 months after LC (Fig.4).

The occurrence of BD injuries is obviously dependent on surgical skill, the condition of the patient, especially if cholecystitis is present or not, and on the type of surgical approach [1, 13, 20, 22–31]. In our series the LCs were performed almost exclusively by four staff surgeons or supervised by one of them. To improve our standards and to counteract major injuries, the following steps were taken: We recorded all the LCs on tape (saved for three months). A low threshold for the selective use of IOC was adopted [19, 21, 26, 27], and surgery was performed strictly according to the "flag dissection" technique described above [9–11, 25, 31]. We decided not to divide any tubular structure without a second opinion. Care was taken to discuss technical difficulties and the possible need for a conversion to OC. Since four of our five major BD injuries were caused by a senior surgeon, we have considered the "safe" surgeon concept, as advocated by Calvete et al. [25], perhaps a better term than "experienced." With these preventive measures, there has been no major BD injury in our last 500 LCs. It has also been shown in other series of LC and OC that a reduction of BD injuries may be possible [2–4, 15]. The increase in significant complications after LC for acute cholecystitis may indicate that a more experienced (safe) surgeon should be selected and there should be a very low threshold for conversion and IOC. It is usually recommended to repair a severed duct at the initial operation if the expertise is at hand [1, 5, 10, 14, 17, 18, 20, 28, 29]. Obviously, it is compulsory to first accurately delineate the injury with IOC or intraoperative ERC. If this cannot be done, it is probably better to just drain and refer the patient to a better-equipped center with the endoscopic, radiological and surgical expertise [1, ,9, 16–18]. It is generally agreed that reconstruction of a completely transected duct should be done with a Roux-en-Y hepaticojejmiostomy [1, 5, 18, 28, 29]. It has been debated whether the anastomosis should be stented [5, 10, 11, 14, 18, 20, 28]. We prefer to have a limb of a T-tube bridging the anastomosis for at least a couple of months for drainage and easy cholangiographic follow-up (Fig. 1D). It is a well-known fact that hilar (types E_2–E_3) injuries are prone to stricture [1, 11, 13, 18], as in one of our patients (case 5, Table 2). This is even more complicated not only because of the limited space in the hepatic hilum (as opposed to CBD injuries), but also because the blood supply to the duct remnant may be poor, usually originating from below and also not infrequently affected by the injury [5].

Routine use of IOC has been debated ever since it was recommended by Mirizzi in 1932 [30]. The view that IOC provides a safeguard against ductal injury is controversial, and IOC is currently used routinely or selectively [19, 21, 26, 27]. IOC can also give a false sense of security, and BD injuries may also be caused by catheter manipulation at IOC [28]. Furthermore, IOC does not prevent BD injuries induced before radiology, and lesions produced after IOC are not revealed [19, 26, 27]. Also, misinter-

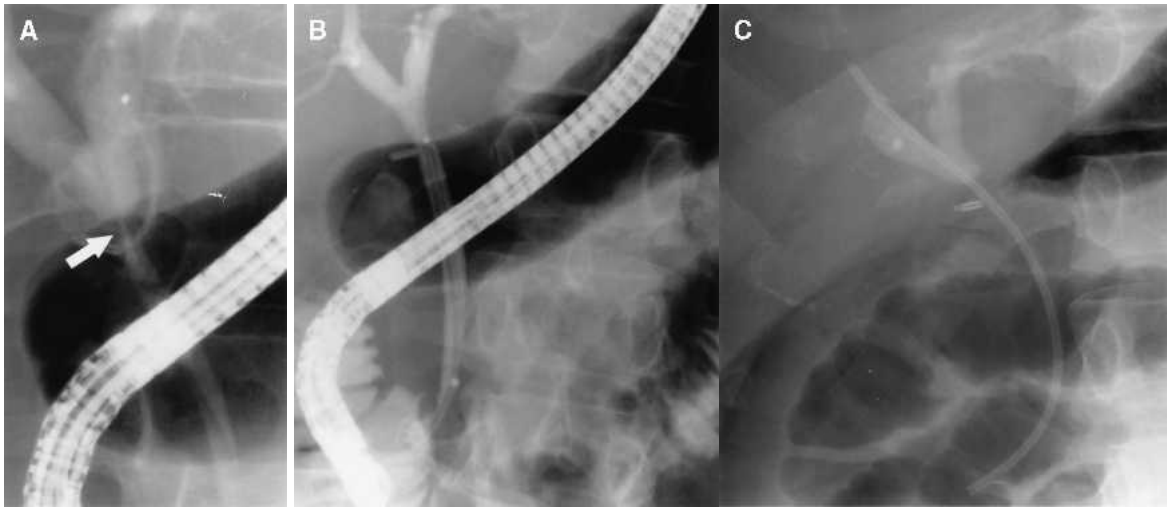

Fig. 4. (**A**–**C**). Type D injury, ERC (**A**) Five weeks after LC; tight stricture at the hilum with proximal dilatation of the intrahepatic BDs. (arrow). Clips from the LC are found adjacent to but clearly below the stricture. (**B**) After balloon dilatation; the deflated balloon is still in position. (**C**) A stent is finally inserted.

pretation of the radiograms is not uncommon. On the other hand, IOC is obviously a tool for early detection of BD injuries and may reduce the extent of BD damage [5, 21]. Therefore, IOC should always be used in cases with the slightest anatomic uncertainty [1]. The surgical technique is crucial, including firm lateral-caudal traction of the GB pouch and meticulous dissection close to the GB, with good exposure of the lower part of the GB [1, 9, 13, 23, 31].

The bile duct anatomy is variable, and aberrant (or accessory) BDs, usually from segment VI and/or VII in the right liver lobe, may cross the triangle of Calot (cf. Fig. 1a). They have been reported in connection with BD injuries at LC and OC [21, 22, 30]. Although described in up to 28% in autopsy series [21], aberrant BDs are seldom the cause of BD injury [1, 21–32, 33]. in our series abnormal BD anatomy was documented (IOC) only in the case with a type C injury, in which a 2-mm aberrant segment VI/VII BD was transected. Generally, reconstruction (Roux loop) should be performed in this situation. Misinterpretation of the anatomy—mistaking the CBD, CHD, or the right hepatic duct for the cystic duct—is the cause behind most severe BD injuries [1, 12, 13, 19, 23, 24], the "classical" injury.

In our series of patients with major BD injuries, there were technical difficulties in three patients as a result of acute cholecystitis (cases 2, 4, and 5, Table 2). The lesions were recognized intraoperatively and repaired immediately. On the other hand, in the two patients with major BD injuries operated on electively (cases 1 and 3), without acute or chronic cholecystitis, the BD lesions were not detected initially and reoperation was necessary. A higher detection rate of BD injuries in acute cholecystitis than in elective patients has been reported by others [1].

Although major BD injuries have been shown to be rare, it is obvious that they remain a significant problem in LC biliary surgery [25] and every effort must be made to reduce these devastating complications [33, 34]. However, there are ways to improve current techniques and, hopefully, a reduction in BD injuries will eventually be achieved.

References

1. Strasberg SM, Soper NJ. An analysis of the problem of biliary injury during laparoscopic cholecystectomy. J. Am. Coll. Surg. 1995;180: 101–125
2. Girard RM, Morin M. Open cholecystectomy: its morbidity and mortality as a reference standard. Can. J. Surg. 1993;36:75–80
3. Roslyn JJ, Binns GS, Hughes EFX. Open cholecystectomy: a contemporary analysis of 42,474 patients. Ann. Surg. 1993;218:129–137
4. Konsten J, Gouma DJ, von Meyenfeldt MF, et al. Long-term follow-up after open cholecystectomy. Br. J. Surg. 1993;80:100–102
5. Andren–Sandberg Å, Johansson S, Bengmark S. Accidental lesions of the common bile duct at cholecystectomy. II. Results of treatment. Ann. Surg 1985;201:452–455
6. Mac Fadyen BV, Vecchio R, Ricardo AE, et al. Bile duct injury after laparoscopic cholecystectomy: The United States experience. Surg. Endosc. 1998;12:315–321
7. Deziel DJ, Millikan KW, Economou SG. Complications of laparoscopic cholecystectomy: a national survey of 4,292 hospitals and an analysis of 77,604 cases. Am. J. Surg. 1993;165:9–14
8. Richardson MC, Bell G, Fullarton GM, et al. Incidence and nature of bile duct injuries following laparoscopic cholecystectomy: an audit of 5913 cases. Br. J. Surg. 1996;83:1356–1360
9. Doctor N, Dooley JS, Dick R, et al. Multidisciplinary approach to biliary complications of laparoscopic cholecystectomy. Br. J. Surg 1998;85:627–632
10. DeWit LTh , Rauws AJ, Gouma DJ. Surgical management of iatrogenic bile duct injury. Scand. J. Gastroenterol. 1999;34(Suppl 230):89–94
11. Lillemoe KD. Benign post-operative bile duct strictures. Baillirés Clin. Gastroenterol. 1997;II(4):749–779
12. Rosenqvist H, Myrin S-O. Operative injuries to the bile ducts. Acta Chir. Scand. 1960;19:92–107
13. Moossa AR, Mayer AD, Stabile B. Iatrogenic injury to the bile duct. Who, How, Where?. Arch. Surg. 1990;125:1028–1031
14. Raute M, Podlech P, Jaschke W, et al. Management of bile duct injuries and strictures following cholecystectomy World J. Surg. 1993;17:553–562
15. Newman C, Wilson R, Newman L, et al. 1525 laparoscopic cholecystectomies without biliary injury: A single institution's experience. Am. Surg. 1995;61:226–228
16. Ryan ME, Geenen IE, Lehman GA, et al. Endoscopic intervention for biliary leaks after laparoscopic cholecystectomy: a multicenter review. Gastrointest. Endosc. 1998;47:261–266
17. Robinson TN, Stiegman GV, Durham JD, et al. Management of major bile duct injury associated with laparoscopic cholecystectomy. Surg. Endosc. 2001;15:1381–1385

18. Hart RS, Passi RB, Wall WJ. Long-term outcome after repair of major bile duct injury created during laparoscopic cholecystectomy. H.P.B. Surg. 2000;2:325–332
19. Fletcher DR, Hobbs MST, Phil D, et al. Complications of cholecystectomy: Risks of the laparoscopic approach and protective effects of operative cholangiography. A population based study. Ann. Surg. 1999;229:449–457
20. Stewart L, Way LW. Bile duct injuries during laparoscopic cholecystectomy: factors that influence the results of treatment. Arch. Surg. 1995;130:1123
21. Kullman E, Borch K, Lindström E, et al. Value of routine intraoperative cholangiography in detecting aberrant bile ducts and bile duct injuries during laparoscopic cholecystectomy. Br. J. Surg. 1996;83:171–175
22. Moosa AR, Easter DW, Van Sonnenberg E, et al. Laparoscopic injuries to the bile duct. A cause for concern. Ann. Surg. 1992;215:203–208
23. Davidoff AM, Pappas TN, Murray EA, et al. Mechanisms of major biliary injury during laparoscopic cholecystectomy. Ann. Surg. 1992;215:196–202
24. Olsen D. Bile duct injury during laparoscopic cholecystectomy. Surg. Endosc. 1997;11:133–138
25. Calvete J, Sabater L, Camps B, et al. Bile duct injury during laparoscopic cholecystectomy. Myth or reality of the learning curve?. Surg. Endosc. 2000;14:608–611
26. Ladosci LT, Benitez LD, Filippone DR, et al. Intraoperative cholangiography in laparoscopic cholecystectomy: a review of 734 consecutive cases. Am. Surg. 1997;63(2):150–156
27. Wright KD, WeEwood JM. Bile duct injury during laparoscopic cholecystectomy without operative cholangiography. Br. J. Surg. 1998;85(2):191–194
28. Rossi RL, Tsao JI. Biliary reconstruction. Surg. Clin. North Am. 1994;74:825–841
29. Ahrendt SA, Pitt HA. Surgical therapy of iatrogenic lesions of biliary tract. World J. Surg. 2001;25:1360–1365
30. Mirizzi PL. Operative cholangiography. Surg. Gynecol. Obstet 1937;65:702–710
31. McIntyre RC, Bensard DD, Stiegmann GV, et al. Exposure for laparoscopic cholecystectomy dissection adversely alters biliary ductal anatomy. Surg. Endosc. 1996;10:41–43
32. Branum G, Schmitt C, Baillie J, et al. Management of major biliary complications after laparoscopic cholecystectomy. Ann. Surg. 1993;217:532–541
33. Boerma D, Rauws E, Keulemans Y, et al. Impaired quality of life 5 years after bile duct injury during laparoscopic cholecystectomy. A prospective analysis. Ann. Surg. 2001;234: 750–757
34. Savander S, Lillemoe K, Prescott C, et al. Laparoscopic cholecystectomy-related bile duct injuries. A health and financial disaster. Ann. Surg. 1997;225:268–273