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SURGICAL ENDOSCOPY
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Contribution of intraoperative cholangiography to incidence and outcome of common bile duct injuries during laparoscopic cholecystectomy

K. Ludwig,[1] J. Bernhardt,[2] H. Steffen,[1] D. Lorenz[3]

[1] Department of Surgery, Klinikum Suedstadt Rostock, Suedring 81, D-18059 Rostock, Germany
[2] Department of Surgery, University of Greifswald, Loefflerstrasse 23, D-17487 Greifswald, Germany
[3] Department of Surgery, Unfallkrankenhaus Berlin-Marzahn, Warener Strasse 7, D-12683 Berlin, Germany

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Abstract
Background: In the present study we examined, in a meta-analysis of the literature, the contribution of intraoperative cholangiography (IOC) to incidence, type, and time of diagnosis of common bile duct (CBD) injuries during laparoscopic cholecystectomy (LC).
Materials and methods: Forty of 2104 reports were enrolled for analysis. In 26 reports we found exact information on type, location and repair of 405 major injuries and in a subgroup examination we selected 103 major injuries with detailed information as to the event and size of CBD injury in association with IOC.
Results: The main incidence of CBD injuries was 0.36%. Using the method of routine IOC the incidence was 0.21% and the rate of diagnosis at the time of cholecystectomy 87% in contrast to selective use of IOC with 0.43% and 44.5%. In 405 cases of major CBD injuries, severe injuries predominated in 83.9% of the cases. Reconstruction with the help of a bilio-digestive anastomosis was necessary in 45.7% of all patients. In 34.8% of the cases a second intervention had to be made in the follow-up of 4 years after LC. The analysis of type, severity, recognition, and follow-up of CBD injuries during LC w/wo IOC showed significant advantages for doing routine IOC.
Conclusions: The use of IOC can avoid severe types of CBD injuries during LC, increase the recognition at the time operation, and influence the success of repair and outcome of the patients.

Key words: Common bile duct injury — Laparoscopic cholecystectomy — Intraoperative cholangiography

Correspondence to: K. Ludwig

Common bile duct injuries are among the most serious complications of laparoscopic cholecystectomy. While such injuries in connection with open cholecystectomies have been determined to have an average incidence of 0.2–0.3% in recent years, a risk of injury three times as high (0.2–0.6%), associated with the laparoscopic technique, can be registered with the introduction of the laparoscopic cholecystectomy (LC), even after completion of the learning curve of this technique [1, 12, 17, 29, 46]. Besides the frequency, however, the number of serious lesions and rate of delayed diagnosis have also increased, as a result of which the outcome of affected patients is influenced [35]. In order to illustrate the seriousness and extent of injury, a classification system is necessary, one which, with consideration to modern aspects, characterizes the localization and proceedings with respect to therapeutic consequences. One widely propagated classification goes back to BISMUTH; however, it considers primarily anatomical aspects. Neuhaus et al. presented a new classification in Germany, which at present optimally fulfills all requirements with respect to CBD injuries during LC and which served for authors as the basis of the following analysis of the literature [27].

In connection with CBD injuries there is discussion as to whether the IOC represents a suitable procedure for avoiding injury. Advocates of the IOC argue that the representation of the biliary anatomy promotes protection against transections of the CBD or at least helps to reveal lesions at an early stage (intraoperatively) when identification of structures has been faulty and accidental injury has occurred [23, 42]. Opponents of the IOC question the protective influence of the IOC and use the arguments of prolonged surgery, limited practicability and increased costs. Within the context of this controversy it has been primarily been absolute frequencies of injury with or without IOC which have been presented up to now. The questions of seriousness of

Table 1. Classification of CBD injuries according to Neuhaus et al. [27]

Type	Kind of injury	Specification
A	Periphery minor leak	A1 — insufficiency of the cystic duct A2 — aberrant bile duct
B	Occlusion of CBD without sharp injury	B1 — incomplete B2 — complete
C	Tangential injury/dissection	C1 — small dissection (< 5 mm) C2 — extended dissection (> 5 mm)
D	Complete transsection	D1 — without fault D2 — with fault
E	(Late) stenosis of the CBD	E1 — short CBD stenosis (< 5 mm) E2 — extended CBD stenosis (> 5 mm) E3 — stenosis of the hepatic branch E4 — stenosis of hepatic duct or segmental bile duct

injury and recognition and outcome of CBD injuries during LC have so far been answered unsatisfactorily and are the subject of this study.

Materials and Methods

In review of the literature on incidence, nature, IOC relevance and outcome of CBD injuries during LC, 93 reports were primarily selected out of a total of 2104 sources. After exclusion of all the reports (20 sources) with an incidence of injury of over 1.5% from the period 1990–1994 and a further 33 studies in which the data was insufficient or in which there were double publications, there remained 40 papers suitable for the analysis. Sixteen studies had a multicentered and 24 studies had a single-centered setup. In order to analyze more closely the nature of the injury, all selected papers were examined with respect to localization and follow-up therapy of the CBD injuries and post-classified according to Neuhaus et al. [27] (Table 1). Exact information was found on a total of 405 major injuries in 26 studies. Minor complications (cysticus and aberrating bile duct leaks, type A according to Neuhaus et al.) could not be considered in the therapy assessment due to differences in proceedings, localization, and treatment. In a subgroup analysis of 13 studies, there were a total of 103 major injuries selected and studied according to case-specific injury proceedings and dependence on IOC.

For statistical analysis, the χ^2 test was used; $p < 0.05$ was chosen as the statistically significant value.

Results

A total of 327,523 LC could be registered. The average incidence of CBD injuries was 0.36% (range, 0–1.4%). In studies with LC and accompanying routine IOC, there was registered a significantly lower rate of CBD injury compared to the LC with selective cholangiography (0.21 vs 0.43%, $p < 0.05$). Of the injuries, 54.7% (range, 0–100%) were diagnosed intraoperatively and 45.3% (range, 0–100%) were diagnosed postoperatively. With routine use of IOC, 90% of all injuries could be diagnosed intraoperatively, which corresponded to a detection rate twice as high as with the selective use of IOC (90% vs 44.5%, $p < 0.05$).

Closer examination of 405 major injuries revealed that incomplete or complete transection injuries (type C) and dissection injuries (type D) of the CBD, with 83.9% (43.9% vs 40%), were the most common (Table 2). Whereas a bilio-digestive anastomosis was necessary in 45.7% of all patients, this rate was 80.8% ($p < 0.05$) for the dissection injuries alone (type D). With artificial small or complete transections of the CBD, repair using a direct suture or a bilio-biliary anastomosis could be carried out in 71.3% of the cases. Occlusion stenosis following faulty clip application (type B) occurred in 8.4% of the injuries. In these cases, the majority incomplete occlusions (type B1) could be treated endoscopically. In the cases of complete occlusion (type B2) a bilio-digestive anastomosis as a definitive therapy was made necessary in 87% of the patients. Late postoperative stenosis of the different parts of the bile duct system (type E) occurred in 7.6% of the cases and was treated primarily by performing endoscopic interventions such as balloon dilatation or (double) stenting.

For 34.8% of the patients, reintervention was necessary. Patients with complete transection injuries and short or extended dissection injuries, especially in cases of postoperative diagnosis, and late CBD stenosis >5 mm, had the lowest chances of success of primary treatment.

In regard to the detection of bile duct injuries, the character of the injury influences the point of time of diagnosis. Thus, type B and E injuries can in fact only be recognized postoperatively, something which has been confirmed in this study. Type C and D injuries occurred at a nearly equal rate and were detected in approximately half of the patients intraoperatively or postoperatively (44.4 vs 55.6%). A relevant significance level did not emerge in this context.

Whereas small incision injuries to the CBD (type C1) made up three-fourths of all injuries for LC with IOC, dissection injuries >5 mm (type D2) were most common for LC without IOC, making up 43.6%. Postoperatively occurring late stenosis (type E) showed an even distribution. Occlusion injuries censed by faulty clip placement did not occur in the IOC group (Table 3).

In the IOC group, a total of 76.9% of the injuries were detected intraoperatively. A choledochus lesion occurred 5 times (19.2%) after a previously completed, normal IOC. Of 20 intraoperatively diagnosed choledochus lesions, 13 (65%) of these were type C1 injuries which resulted from a misinterpretation of the cystic duct. In these cases a mini-incision for the IOC had inadvertently been performed in the CBD region and the error had shown up in the cholangiography. All patients could be treated with laparoscopic or open placement of

Table 2. Characteristics of 405 major CBD injuries with type, time of recognition, repair, and redo operations

Type of injury	*n*	Intraoperative detection (%)	Therapy (%)				Redooperation (%)
			Dir. suture	Bil.-bil. anast.	Bil.-dig. anast.	Endoscop.	
B1	19	—	4 (21)	—	—	15 (79)	5 (26)
B2	15	—	2 (13)	—	13 (87)	—	3 (20)
C1	109	61 (56)	71 (65)	8 (7)	6 (5.5)	24 (22)	21 (19)
C2	69	31 (45)	42 (61)	6 (8.7)	19 (27.5)	2 (2.9)	29 (42)
D1	62	41 (52)	—	14 (22.5)	48 (77.5)	—	23 (37)
D2	100	47 (47)	—	17 (17)	83 (83)	—	47 (47)
E1–4	31	—	—	—	16 (51.6)	15 (48.4)	13 (42)
Total	405	108 (52.9)	119 (29.4)	45 (11)	185 (45.7)	56 (13.8)	141 (34.8)

Table 3. Characteristics of 103 major CBD injures according to case-specific proceeding and depence on IOC

	Without IOC ($n = 78$)	With IOC ($n = 26$)	$p < 0.05$
Type B injury	11 (14%)	—	s.
Type C injury	23 (29.6%)	21 (80.7%)	s.
Type D injury	36 (46.1%)	2 (7.7%)	s.
Type E injury	8 (10.2%)	3 (11.5%)	n.s.
Intraoperative detection	17 (21.7%)	20 (76.9%)	s.
Repair by suture or bil.-bil. anastomosis	27 (34.6%)	20 (76.9%)	s.
Repair by bil.-digestive anastomosis	45 (57.7%)	5 (19.2%)	s.
Redo-procedure necessary	32 (41%)	2 (7.7%)	s.

sutures without reintervention. The overall reintervention rate in the IOC group was 7.7%; here were two cases of stenosis after bilio-biliary anastomosis, in which endoscopic dilatation proved unsuccessful. A bilio-biliary anastomosis, was necessary for a total of 19.2% of the patients.

In the group of patients with bile duct injuries without IOC, only 21.7% of the injuries could be detected intraoperatively, which turned out to be significant when compared with the IOC group ($p < 0.001$). A bilio-digestive anastomosis was necessary for 45 patients in this group (57.7%) for reconstruction, which also represented a significance level compared with the IOC group ($p < 0.001$). In 41% of the patients a reintervention was necessary. These cases were mainly patients with postoperatively diagnosed type D2 injuries. Whereas the presence of E1 and E2 injuries showed no evident connection with IOC, type E3 and E4 lesions were present exclusively in patients who had undergone a cholecystectomy without cholangiography.

Discussion

Iatrogenic common bile duct lesions are to be considered the most serious complication during the procedure of cholecystectomy. After completion of the learning curve upon the introduction of LC, a two to three times higher risk of injury for this minimally invasive surgery can be registered for this procedure, as shown by extensive statistics in the literature [2, 17, 39, 46]. Thus, the most important measure is that of prevention of injury. In addition, however, the nature and extent of injury, the point of time of its detection, and adequate treatment are also important factors which influence the outcome of the patient.

Prevention of CBD injuries

CBD injuries occur as a rule during LC as a result of a misinterpretation of anatomic relations. In the majority of cholecystectomies, the situs is located easily and all the relevant structures are able to be assessed with little manipulation by the experienced surgeon. Chronic fibrous alterations, anatomical variants of the norm or inflammatory alterations associated with acute cholecystitis can, however, make the preparation of the anatomical structures of the bile ducts more difficult. The misinterpretation of ductus choledochus as cystic duct, extreme proximity of gallbladder to the common bile duct, or preparation too far away from the gallbladder can be named as examples of major risk factors within this context. The question is raised of how the operating surgeon is to confront these critical moments [29, 42].

The majority of authors require a preparation of all relevant structures in the triangle of Calot. The guiding structure for dissection should be the wall of the gallbladder. Tenting by pulling too hard laterally on the gallbladder should be avoided. Before severing a structure, its anatomical position must be defined. This mode of proceeding is effective when the anatomical relations are regular, but this can be severely limited when adhesions and inflammatory alterations are present. Advocates of the selective IOC favor cholangiography in this situation in order to gain a better orientation in relation to the CBD and, for example, to avoid thermally inflicted lesions caused by preparation too close to the CBD. Fletcher et al. could demonstrate in a multi-

centric analysis that there was a significant influence of IOC on the risk of injury, especially when complicated intraoperative conditions existed. Thus the incidence for laparoscopic surgery without IOC was 0.4% in uncomplicated operative conditions and 1.7% in complicated operative conditions. For LC with IOC the rates of injury were 0.2%, regardless of operative conditions [12].

Advocates of a general IOC basically attribute an injury-preventing influence to the routine representation of the anatomical conditions of the bile ducts. In a series of studies, however, this advantage could not be backed by conclusive evidence. This analysis, on the other hand, shows clear advantages for routine IOC. In the studies in which the IOC was performed in more than 80% of the operations, choledochus lesions occurred in 0.21%. In contrast to these results, the incidence of 0.43% associated with selective administration of the procedure was significantly higher ($p < 0.02$). Buanes et al., for example, in their Scandinavian study, registered an increase in the injury rate of up to 0.9% associated with a decrease in IOC frequency [3].

Alternatively, the identification of the anatomical situation with the help of intraoperative ultrasound examination (IUS) is possible. The advantages of IUS lie in the possibility of repeated use and the simultaneous assessment of vessel structures in the ligament [9]. This has not yet not become a common procedure: in Germany IUS is used by only 5% of hospitals [23].

Severity of CBD injuries

While minimal leakage from smaller occult bile ducts or an incomplete cysticus occlusion can nearly always be brought under control through endoscopic measures (stenting, naso-biliary tube, papillotomy), stenoses caused by incorrect clip application or transaction or dissection injuries represent the real problematic nature of the therapy of CBD injuries following LC. The results of this analysis show that 46% of injuries were caused by a complete transection or more or less extensive dissection. Of the postoperatively diagnosed stenoses, 16% were due to faulty clip application and accidental late stenoses (8.4% vs 7.6%). In 60.3% of these patients a bilio-digestive anastomosis was necessary, of whom 35% had to undergo surgery again within 4 years because of complications at the anastomosis. Gouma determined that biliary-digestive reconstruction following CBD injuries is associated with a morbidity of 31% and a mortality of 7% [17]. Kullmann et al. registered serious long-term complications in 25–50% of the patients subsequent to bilio-digestive anastomosis [20]. Even Neuhaus reported that, following reconstructive surgery, 7.7% of his patients required a liver transplant at a later date [27].

Within this context, the subgroup analysis showed a clear advantage for the group of patients with CBD injury and IOC. In 73% of the cases this was a minimal incision injury (type C1), while in the group without IOC this type of injury had a lower incidence of 14.1%; however, dissection injuries were clearly shown to dominate in this group, with 43.6% of the cases. The large number of type C injuries in the IOC group is a result of the operative algorithm. When the CBD is mistaken for the cystic duct, the mini-incision for the IOC is first carried out. The resulting cholangiography shows the identification error, thus avoiding the further incorrect preparation followed by the inevitable severing of the structure. In nearly every case, the immediate detection and treatment of the injury using a direct suture (with or without a T-tube) is possible. In the summary of our data it can thus be determined that the nature and extent of CBD injuries show significantly lower levels of severity in connection with cholecystectomy with IOC.

Recognition of CBD injuries

Besides possessing advantages in terms of ease of implementation and reduction in the rate of injuries, IOC is also of interest because of the role it plays in recognizing CBD lesions. The data concerning the rate of intraoperative diagnosis varies greatly. For example, whereas Gitter et al. [16] concluded from an Austrian survey that 47% of injuries were detected intraoperatively, other studies could only register rates of 24–43% [5, 14, 23, 46]. A number of authors note that, through routine IOC, not only can injuries be avoided, but they can also be increasingly detected intraoperatively [21, 33, 41, 45]. In studies of routine IOC, 90% of the injuries could be diagnosed intraoperatively, whereas in selective practice the rate was only 44.5%. Similar results were observed in the nationwide German study. Hospitals using routine IOC discovered 92% of the lesions during the surgery. With selective application, only 67% were observed. In hospitals which totally abstain from IOC, surgeons are only able to diagnose half of the cases during LC [23].

In the analysis presented, out of 340 transection and dissection injuries, 180 (52.9%) were recognized intraoperatively. In 19.4% of these patients, a reconstruction procedure without the help of a biliary-digestive anastomosis was possible and in 21.1% of the cases a re-operation had to be performed. In contrast, in the group of 160 (47.1%) postoperatively detected CBD injuries, only 10% of the injuries had undergone repair without biliary-digestive reconstruction, but more than 55% needed a re-operation, whereas in 16% of the cases a long-term endoscopic therapy with the use of a naso-biliary tube was successful. It thus becomes clear that the immediate detection and treatment of bile duct injuries improves the patients' outcomes. On the other hand, injuries detected too late should be treated in specialized centers. In such a situation, there is no need for an emergency course of action; the high rate of second and third-time surgeries will undoubtedly be reduced in this way.

Repair of CBD injuries

Different procedures used in dealing with the repair of CBD injuries have been described in numerous sources

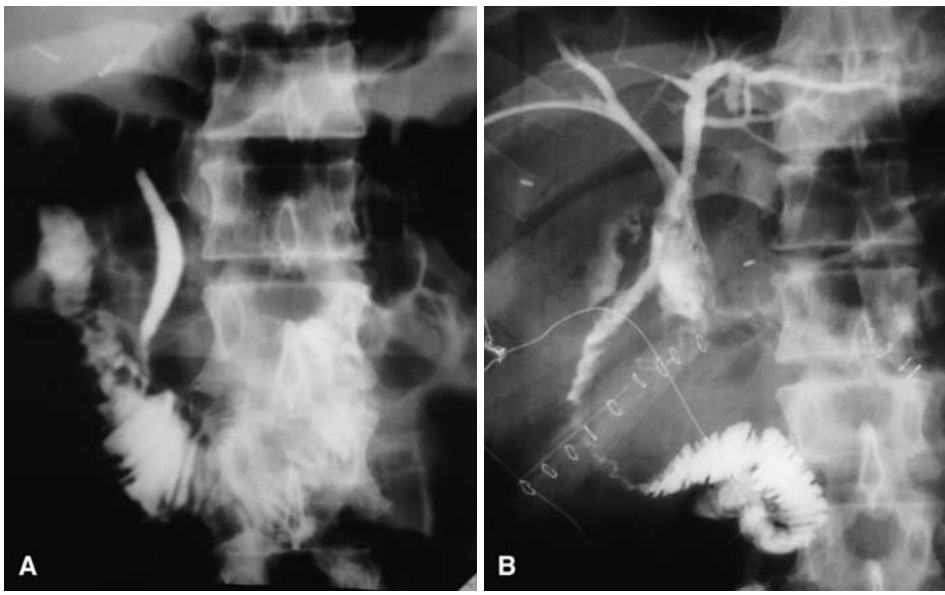

Fig. 1. A,B D2 injury near the hepatic branch and repair by a biliodigestive anastomosis.

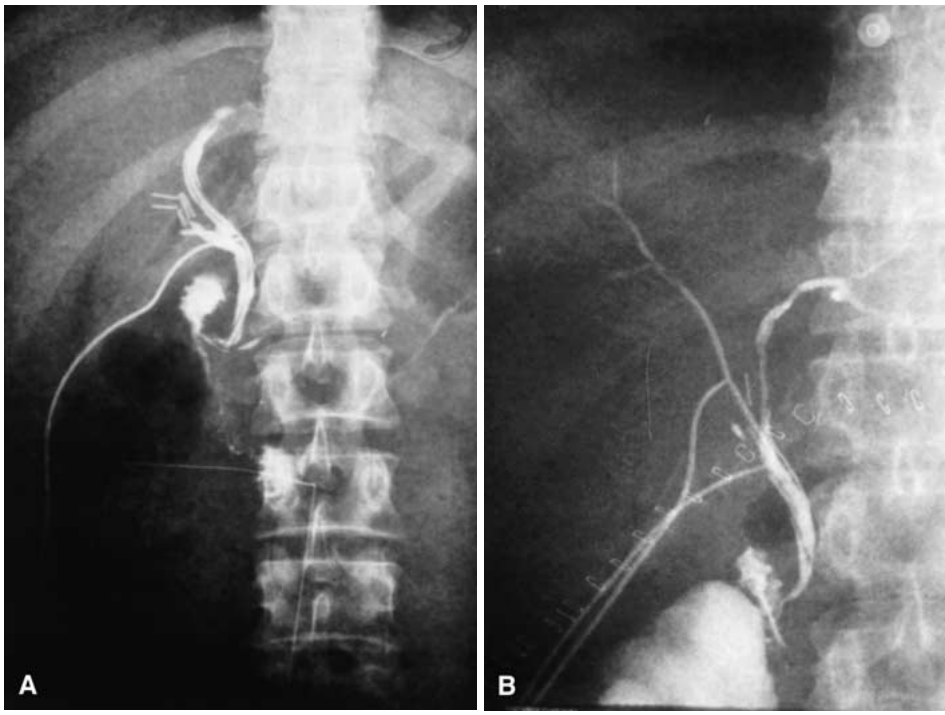

Fig. 2. A,B D2 injury of both hepatic ducts distal of the hepatic branch and repair by bilio-bilary anastomoses including the use of two t-tubes.

[2, 15, 27, 29, 32]. Every operating surgeon should principally be confident about his experience in dealing with CBD injuries and should not, in cases of doubt, hesitate to transfer a patient to a specialized institution. In addition, the time of detection and the respective local situation determine the nature of the reconstruction [35]. As an example, it makes little sense to force a bilio-biliary anastomosis under high tension or in case of bilious peritonitis. Both procedures, if performed, would necessarily lead to a new revision. In the views of the authors, there is possibly agreement on the following suggestions as to how to treat CBD injuries at present: smaller leaks from deviating bile ducts or out of an insufficiently closed cysticus stump can nearly always be treated successfully by using endoscopic measures (papillotomy, stenting, naso-biliary tube). In some cases an additional percutaneous drainage for the subhepatic region can be necessary. Incomplete duct occlusion caused by incorrect placement of clips as well as short late stenoses can also be treated primarily endoscopically, with no time limit (balloon dilatation, (double) stenting). If the endoscopic treatment is unsuccessful, elective surgical reconstruction may be performed.

For the case of an intraoperatively diagnosed incorrect incision (type C1) the conversion and direct suture or the anastomosis with or without a T-tube is recommended. In individual cases and when the anatomical conditions are good, it may be possible for bile duct surgeons experienced in laparoscopic procedures to stitch a small lesion together without having to convert. All other intraoperatively detected transection and dissection injuries (type C2, D1–2) make the conversion necessary, with either tension-free bilio-biliary anastomosis with a general T-tube drainage or bilio-digestive repair, which can be technically quite difficult when the CBD has a small lumen (Figs. 1, 2).

Transection or dissection injuries which have been discovered late necessitate reconstruction by means of a bilio-digestive anastomosis in nearly every case without exception. Here one should always aim for the widest possible anastomosis and take care to perform a subtle mucosa adaptation. Only in exceptional cases does a bilio-biliary anastomosis come into question for such a situation; on the other hand, complete CBD occlusions (type B2) and short late stenosis (type E2, 4) are possibly better suited to this type of reconstruction.

In summary, on the basis of our data presented, it can be concluded that the liberal use of IOC helps to reduce the incidence of CBD injuries, minimizes the severity of injury, facilitates intraoperative detection, and improves the outlook of affected patients. In the hands of the experienced surgeon, the procedure prolongs the LC by just an average of approximately 6–8 min at justifiable extra expense. It still remains doubtful, however, as to whether the general use of IOC may be recommended on these grounds.

References

1. Adams DB, Borowicz MR, Wootton FT, Cunningham JT (1993) Bile duct complications after laparoscopic cholecystectomy. Surg Endosc 7: 79–83
2. Berci G (1998) Complications of laparoscopic cholecystectomy. Surg Endosc 12: 291–293
3. Buanes T, Adamsen S, Hjelmquist B, Ovaska J (1997) The Scandinavian national registries of laparoscopic cholecystectomy. A comperative audit. Surg Endosc 11: 184
4. Cuschieri A, Shimi S, Banting S, Nathanson LK, Pietrabassa A (1994) Intraoperative cholangiography during laparoscopic cholecystectomy. Surg Endosc 8: 302–305
5. Davidoff AM, Pappas TN, Murray EA, Hilleren DJ, Johnson RD, Baker ME, Newman GE, Cotton PB, Meyers WC (1992) Mechanisms of major biliary injury during laparoscopic cholecystectomy. Am Surg 215: 196–208
6. Davis CJ, Arregui ME, Nagan RF, Sharr C (1992) Laparoscopic cholecystectomy: The St. Vincent experience. Surg Laparaosc Endosc 2: 64–68
7. Decker D, Kania U, Decker P, Low A, Hirner A (1995) Gallenwegsverletzungen nach laparoskopischer Cholezystektomie. Zentralbl Chir 120: 467–471
8. Eberle R, Klaerner H, Leoro G, Wieder HF (1993) Laparoskopische Cholecystektomie. Ergebnisse nach 1688 Eingriffen. Min Invasive Chir 3: 102–108
9. Falcone RA, Fegelman EJ, Nussbaum MS, Brown DL, Bebbe TM, Merkar GL, Johannigman JA, Luchette FA, Davis K, Hurst JM (1999) A prospective comparison of laparoscopic ultrasound vs. intraoperative cholangiogram during laparoscopic cholecystectomy. Surg Endosc 13: 784–788
10. Ferguson CM, Rattner DW, Warshaw AL (1992) Bile duct injury in laparoscopic cholecystectomy. Surg Laparosc Endosc 2: 1–7
11. Fiore NF, Ledniczky G, Wiebke EA, Broadie TA, Pruitt AL, Goulet RJ, Grosfeld JL, Canal DF (1997) An analysis of perioperative cholangiography in one thousand laparoscopic cholecystectomies. Surg 122: 817–821
12. Fletscher DR, Hobbs MST, Tan P, Valinsky LJ, Hockey RL, Pikora TJ, Knuiman MW, Sheiner HJ, Edis A (1999) Complications of cholecystectomy: risks of the laparoscopic approach and protective effects of operative cholangiography. Ann Surg 229: 449–457
13. Galloway SW, Blazeby JM, Tulloh BR, Poskitt KR (1996) Selective cholangiography with laparoscopic cholecystectomy: Review of a protocol. Eur J Surg 162: 373–378
14. Gastinger I, Koeckerling F, Krause W, Schneider B (1992) Die laparoskopische Cholezystektomie. Min Invasive Chir 1: 2–13
15. Gigot JF, Etienne J, Aerts R, Wibin E , Dallegne B, Deweer F, Fortunati D, Legrand M, Vereecken L, Doumont J, Van Reepinghen P, Beguin C (1997) The dramatic reality of biliary duct injury during laparoscopic cholecystectomy—an anonymous multicenter Belgian survey of 65 patients. Surg Endosc 11: 1171–1178
16. Gitter T, Wayand W, Woisetschläger R (1995) Der Stand der laparoskopischen Cholezystektomie in Österreich. Wien Klin Wochenschr 107/2: 61–64
17. Gouma DJ, Go PMN (1994) Bile duct injury during laparoscopic and conventional cholecystectomy. J Am Coll Surg 178: 229–233
18. Hosch SB, Zornig C, Izbicki JR, Prenzel KL, Thonke F, Broelsch CE (1996) Operative Korrektur von Gallengangsverletzungen nach laparoskopischer Cholecystektomie. Zentralbl Chir 121: 290–293
19. Huang SM, Wu CW, Hong HAT, Ming Lui, King KL, Lui WY (1993) Bile duct injury and bile leakage in laparoscopic cholecystectomy. Br J Surg 80: 1590–1592
20. Kullmann E, Borch K, Lindstrom E, Svanvik J, Anderberg A (1996) Value of routine intraoperative cholangiography in detecting aberrant bile ducts and bile duct injuries during laparoscopic cholecystectomy. Br J Surg 83: 171–175
21. Lillemoe KD, Martin SA, Cameron JL, Yeo CJ , Talamini MA, Kaushal S, Coleman J, Venbrux AC, Savader SJ, Osterman FA, Pitt HA (1997) Major bile duct injuries during laparoscopic cholecystectomy. Follow-up after combined surgical and radiologic management. Ann Surg 225: 459–462
22. Loehde E, Raude H, Kleine U, Schairer W, Kraas E (1994) Erfahrungen nach 2200 laparoskopischen Cholezystektomien als Behandlungskonzept des Gallensteinleidens. Zentralbl Chir 119: 371–377
23. Ludwig K, Hunsicker A, Lorenz D (2001) Intraoperative Cholangiografie bei laparoskopischer Cholezystektomie. Chir Praxis 57: 611–618
24. Manger T, Pertschy J, Wolff H (1993) Iatrogene Gallenganglaesionen nach laparoskopischer Cholezystektomie. Minimal Invasive Chirurgie 2: 46–52
25. Moossa AR, Easter DW, VanSonnenberg E, Casola G, DeAgostino H (1992) Laparoscopic injuries to the bile duct. Ann Surg 215: 203–208
26. Mussack T, Trupka AW, Schmidbauer S, Hallfeldt KKJ (2000) Zeitgerechtes Management von Gallenwegskomplikationen nach laparoskopischer Cholecystektomie. Chirurg 71: 174–181
27. Neuhaus P, Schmidt SC, Hintze RE, Adler A, Veltzke W, Raakow R, Langrehr JM, Bechstein WO (2000) Einteilung und Behandlung von Gallengangsverletzungen nach laparoskopischer Cholecystektomie. Chirurg 71: 166–173
28. Nies C, Bauknecht F, Groth C, Clerici T, Bartsch D, Lange J, Rothmund M (1997) Intraoperative Cholandgiographie als Routinemethode? Eine prospective, kontrollierte, randomisierte Studie. Chirurg 68: 892–897
29. Olsen DE (1997) Bile duct injuries during laparoscopic cholecystectomy. Surg Endosc 11: 133–138
30. Peiper M, Emmermann A, Rogiers X, Broelsch CE (1994) Stenosierung des Ductus choledochus durch Metall-Clips nach laparoskopischer Cholecystektomie. Chirurg 65: 217–220

31. Regöly-Merei J, Ihasz M, Szeberin Z, Sandor J, Mate M (1998) Biliary tract complications in laparoscopic cholecystectomy. A multicenter study of 148 biliary tract injuries in 26,440 operations. Surg Endosc 12: 294–300
32. Richardson AJ, Brancatisano R, Avramovic J, Roney W, Little JM (1993) Injuries to the bile duct resulting from laparoscopic cholecystectomy. Aust NZ J Surg 63: 684–689
33. Rossi RL, Schirmer WJ, Braasch JW, Sanders LB, Munson JL (1992) Laparoscopic bile duct injuries: risk factors, recognition and repair. Arch Surg 127: 596–602
34. Schol FPG, Go PMN, Gouma DJ (1995) Outcome of 49 repairs of bile duct injuries after laparoscopic cholecystectomy. World J Surg 19: 753–757
35. Siewert JR, Ungeheuer A, Feussner H (1994) Gallenwegsläsionen bei laparoskopischer Cholecystektomie. Chirurg 65: 748–757
36. Snow LL, Weinstein LS, Hannon JK, Lane DR (1999) Management of bile duct stones in 1572 patients undergoing laparoscopic cholecystectomy. Am Surg 65: 530–547
37. Stuart SA, Simpson TIG, Alvord LA (1998) Routine intraoperative laparoscopic cholangiography. Am J Surg 176: 632–636
38. Torkington J (1999) Laparoscopic cholecystectomy, bile duct injury and the British and Irish surgeon. Ann R Coll Surg Engl 81: 71–72
39. Traverso LW, Hauptmann EM Lynge DC (1994) Routine intraoperative cholangiography and its contribution to the selective cholangiographer. Am J Surg 167: 464–468
40. Traverso LW (1998) Risk factors for intraoperative injury during cholecystectomy. Ann Surg 229: 458–459
41. Vezakis A, Davides D, Ammori BJ, Martin IG, Larvin M, McMahon MJ (2000) Intraoperative cholangiography during laparoscopic cholecystectomy. Surg Endosc 14: 1118–1122
42. Voyles CR, Sanders DL, Hogan R (1994) Common bile duct evaluation in the era of laparoscopic cholecystectomy. 1050 cases later. Ann Surg 219: 744–752
43. Woods MS, Shellito JL, Santoscoy GS, Hagen RC, Kilgore WR, Traverso LW, Kozarek RA, Brandabur JJ (1994) Cystic duct leaks in laparoscopic cholecystectomy. Am J Surg 168: 560–565
44. Yeh TS, Jan YY, Tseng JH, Hwang TL, Jeng LB, Chen MF (1999) Value of magnetic resonance cholangiography in demonstrating major bile duct injuries following laparoscopic cholecystectomy. Br J Surg 86: 181–184
45. Zender FJ, Berg T, Klippel S, Schönleben K (2000) 9 Jahre laparoskopische Cholecystektomie. Erfahrungen in einer Ausbildungsklinik. Chir Praxis 56: 421–448
46. Z'graggen K, Wehrli H, Metzger A, Buechler M, Frei E, Klaiber C, for the Swiss Association of Laparoscopic and Thoracoscopic Surgery (1998) Complications of laparoscopic cholecystectomy in Switzerland. Surg Endosc 12: 1303–1310