Chapter 26
Endoscopic Management of Bile Duct Injury During Laparoscopic Cholecystectomy

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Introduction

Every year in the USA more than 750,000 laparoscopic cholecystectomies (LC) are performed [1]. LC offers many advantages over open cholecystectomy. Among them are less pain and less wound infections, decreased activation of inflammatory mediators, improved cosmesis, and reduced hospital stay. Because of these advantages, in the past two decades LC has rapidly and largely replaced open cholecystectomy for the management of symptomatic gallstone disease. The only potential disadvantage of LC is the higher reported incidence of major bile duct injuries (BDI). It is impossible to estimate the real incidence of iatrogenic injuries of the bile ducts during LC, but it is calculated that it has increased by two to three times (between 0.2 % and 1.7 %) with its advent [2, 3].

BDI are mostly due to misidentification of anatomic structures during LC, excessive use of electrocautery, adhesions in the gallbladder fossa, inaccurate placement of sutures, ligations, and extensive placement of clips [4].

Intense inflammation has been identified as an independent risk factor for the onset of BDI, and some authors recommend conversion to open surgery when this condition is encountered [5, 6].

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Surgical repair was the treatment of choice for BDI in the past, while ERCP was limited to its diagnostic role to better understand the site and extension of the injury [7]. Obviously, after establishing of ERCP as a pure operative tool the respective roles have radically changed.

Postoperative BDI have been classified by Bergman et al. [8] in four types: *Type A* cystic duct leaks or leakage from aberrant or peripheral hepatic radicles, *Type B* major bile duct leaks with or without concomitant biliary strictures, *Type C* bile duct strictures without bile leakage, and *Type D* complete transection of the duct with or without excision of some portion of the biliary tree.

Clinical Features and Diagnosis

Early BDI are those that present within 1 week from surgery, and represent about 10 % of all post-cholecystectomy injuries [9]. The injury is frequently recognized during LC often as a result of unintentional clipping, ligation or section of the common bile duct, and may or may not be associated with biliary leaks. Patients may present with pruritus, jaundice, abdominal pain and fever, or only with alteration of liver function tests (LFT). If a biliary leak is present, bile can be found in surgical drainages or there can be evidence of biliary intra-abdominal collections.

The vast majority of BDI (70–80 %) becomes symptomatic after weeks or months after LC [10], when the injury has evolved into a stricture.

Bile duct strictures (BDS) at distance from LC typically occur at the site of unrecognized minor BDI of the ducts without an associated leak. The clinical presentation can be with pruritus, jaundice, abdominal pain, alteration of LFT, and recurrent cholangitis. If left untreated, these injuries can lead to secondary biliary cirrhosis [11].

The Bismuth classification of post-operative BDS has been described before the advent of LC. The intent of this classification was to guide surgical repair, and has been well correlated with outcome after treatment [12].

According to Bismuth [13] there are five types of BDS. *Type 1:* located at the lower common hepatic duct or bile duct (>2 cm from the hilum); *type 2:* mid-common hepatic duct (<2 cm from the hilum); type 3: stricture located at the hilum; *type 4:* destruction of the hilar confluence (separation of the right and the left hepatic ducts); and *type 5:* involvement of one right hepatic branch.

Abdominal ultrasound can detect dilation of the intrahepatic biliary tree, which associated with elevated LFT and history of LC should lead to the suspicion of biliary injury. The most accurate noninvasive examination to depict the biliary anatomy, the site, and length of the stricture is MRCP with 3D reconstruction [14].

MRCP is very useful before ERCP as a treatment planning strategy tool. It can diagnose biliary leakage from the cystic duct or intrahepatic biliary tree, strictures, or the presence of bile duct stones or other pathologies.

In some cases also CT scan can be useful, especially for the determination of residual liver parenchyma function and assessment of liver atrophy in patients with long-standing biliary injuries.

Endoscopic Management

Endoscopic management varies on the basis of the type of injury, and the presence or not of biliary leakage and the time of onset, whereas management of strictures is mostly dependent on their complexity.

Management of Bile Duct Leaks

The most frequent type of early biliary leak is the one from the cystic duct, and is due to inaccurate cystic duct closure or clip displacement [15]. Delayed leaks are usually a result of thermal or vascular injury during dissection [16]. Suture failure due to high biliary pressure secondary to retained choledocholithiasis is a less frequent cause of leak.

Another cause of bile leak is the presence of a direct communication from the gallbladder to the right hepatic ductal system through the gallbladder bed (Luschka duct) [17, 18]. The best way to prevent biliary leaks and injuries during LC is to be aware of anatomical variations [19], which have to be recognized during the dissection of the gallbladder pedicle.

The main goal of endoscopic treatment of bile leaks is to depressurize the biliary tree by lowering the pressure gradient between the bile ducts and the duodenum at the level of the sphincter of Oddi.

This can be obtained with biliary sphincterotomy, associated or not with removal of retained stones, placement of a nasobiliary drain or of a plastic stent [20].

Complex biliary leaks are associated with strictures and/or loss of substance of the bile ducts.

Management of Bile Duct Strictures

The clinical history of the patient should be carefully evaluated before endoscopic treatment. The clinical suspicion of BDS should always rise especially in patients with elevation of LFT and a history of LC. For instance, the presence of many clips in the right hypochondrion on the plain X-ray may be an indicator of a difficult LC.

The "road map" MRCP is a very useful tool before ERCP that can literally guide the endoscopist to the best biliary drainage choice.

After endoscopic sphincterotomy it is essential to perform a good-quality cholangiogram in order to establish the type and site of the stricture. Strictures can be negotiated only if there is a continuity of the biliary tree (not in case of Bergman type D).

The cholangiographic appearance of BDS is quite typical: the stenotic tract is short, often asymmetric, and angulated. Furthermore, postoperative strictures are also often rich in fibrotic tissue. These features may make the guidewire negotiation through BDS very tricky and in some instances much more difficult in comparison to malignant strictures.

The choice of the wire for stricture negotiation is very important. It is preferable to use hydrophilic wire (0.035, 0.021, or 0.018-inch in diameter) with a straight or curved (J-shaped) tip.

ERCP in these patients should be done in referral centers with experienced endoscopists and assistants. Manipulation of guidewires is generally done by assistants. It requires a lot of patience, skills and optimal fluoroscopic imaging and it should be gentle in order to avoid false routes. During guidewire manipulation, it is important to have the direction of the catheter and the wire in the same axis of the stricture. In very angled strictures, this can be achieved by straightening the common bile duct below the stricture itself by pulling an inflated stone extraction balloon just below the stricture. Some steerable catheters can also be useful in certain cases to orientate the guidewire. At the very first treatment, in most cases it is enough to place at least one large bore (10 French) plastic stent.

Before plastic stents placement, pneumatic balloon dilation of the stricture can be required in certain cases. Pneumatic dilatation alone is highly effective but has up to 47 % of restenosis rate at long term [21–23].

Pneumatic dilatation, if needed, should be preferably done only during the very first treatment, and should be avoided during further procedures, especially in plastic multistenting procedures. Actually, the forceful disruption of the stricture may add further traumatic damage to the tissue and consequential development of a new exuberant fibrotic reaction.

Stents keep the stricture opened for a prolonged period, allowing scar remodeling and consolidation. In case the stricture has not been dilated enough to place a stent, insertion of a 5 or 6 Fr nasobiliary drain for 24–48 h is important to guarantee immediate biliary drainage. The nasobiliary drain acts as a mechanical dilator and at the next ERCP, stent placement is usually possible.

The choice of the type of stent is depending mainly on the type and site of the stricture. Stents can be plastic and fully covered self-expandable metal stents (SEMS). SEMS can be used in some circumstances for BDS in selected patients. Biodegradable biliary stents until now have been experimented only in animal models [24].

Currently, plastic stents are the mostly used for this purpose. Single-plastic stents have achieved unsatisfactory long-term outcomes [25]; therefore, today, the standard endoscopic approach for post-cholecystectomy strictures is the “aggressive multistenting strategy.” This consists in temporary simultaneous placement of multiple large bore plastic stents, over a period of 1 year [26, 27]. ERCP with stents exchanges is generally done every 3 months, with progressive increment of the number of stents at each ERCP, until complete resolution of the stricture at cholangiography (Fig. 26.1). Complete stricture resolution at cholangiography is defined as absence of any significant indentation at the site of previous narrowing.

This treatment has been found to be highly successful, with low recurrence rate. Furthermore, stricture recurrences are generally endoscopically retreated with high success rate [26, 27].

This aggressive multistenting approach consists in gentle and long-term “massaging” of the stricture, allowing it to adapt to the increasing number of stents and to avoid formation of exuberant fibrous tissue.

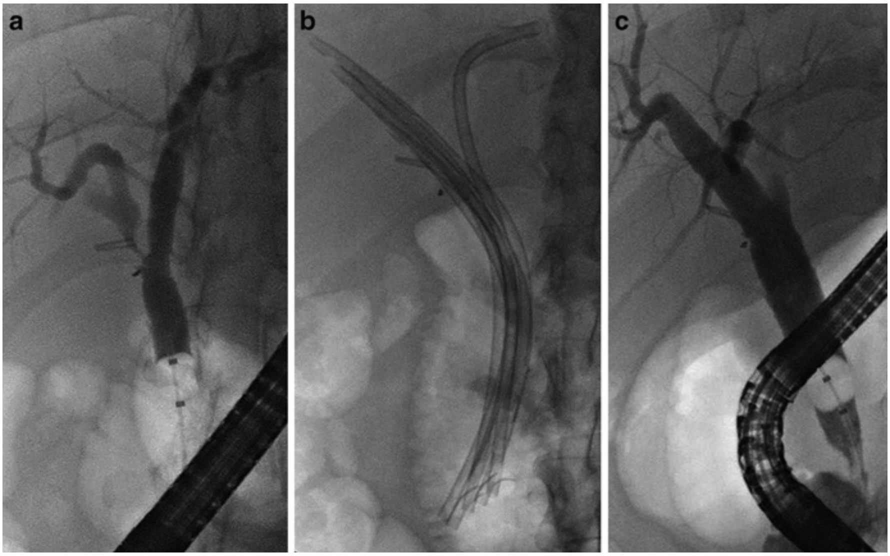

Fig. 26.1 (**a**) Bismuth type V stricture associated with biliary leak. (**b**) Stenting with multiple plastic stents (multiple sessions during 1-year period). (**c**) Final appearance after plastic stents removal

This approach is suggested also by the European Society of Gastrointestinal Endoscopy (ESGE) in the recently published clinical guidelines for endoscopic biliary drainage [20]. According to these guidelines, plastic biliary multistenting is technically feasible in >90 % of patients with highest long-term biliary patency rate in 90 % of postoperative biliary strictures [20].

Obviously, this approach is limited by the need of multiple ERCP sessions over the 1-year period, patient compliance and increased costs.

SEMS are an excellent tool for the treatment of malignant biliary strictures, and have also been increasingly used for the treatment of benign biliary strictures [28, 29].

SEMS must be fully covered and therefore removable if used in benign biliary strictures. Early dislocation and migration are the main problems related to covered SEMS. To overcome this, SEMS with flared ends have been designed [30, 31]. Another problem related to covered SEMS is that these stents can be used only in benign biliary strictures that involve the main bile duct and do not involve the hilum. In terms of costs SEMS are more expensive than plastic stents, but these costs are counterbalanced by the reduction in number of procedures required for plastic multistenting.

Outcomes of Endoscopic Treatment

More than 90 % of uncomplicated biliary leaks heal after biliary sphincterotomy or temporary drainage (nasobiliary drain or plastic stent) with removal of any potentially associated biliary stones [20]. In a limited case series Baron et al. have also evaluated the use of covered expandable metal stents for closure of complex biliary leaks with good outcomes [32]. Hence, there is no discussion about the role of ERCP in the management of bile leaks, but there is still open debate about the optimal treatment of BDS.

Surgical repair has been the mainstay of treatment of BDS for long time. Today endoscopy is the first line treatment because its efficacy is comparable to surgery, but has lower rates of morbidity and mortality [33]. However, surgery remains available when endoscopy fails.

Good outcomes from endoscopic treatment with multiple plastic stents of BDS have been reported in many studies. In most of the studies, BDS were a consequence of different types of surgery (liver transplantation, open cholecystectomy, liver trauma, liver resections and laparoscopic cholecystectomy), with success rates ranging from 69 to 100 % (Table 26.1). Results of endotherapy are also influenced by the location of the stricture.

For instance, in the study by Draganov et al. a high success rate was achieved in patients with Bismuth type 1 or 2 strictures (80 %), and the lowest in type 3 strictures (25 %) [21].

Major complications of endoscopic multistenting are cholangitis, pancreatitis and stent migration, and are more common in patients who are non-compliant with the stent exchange protocol [20].

Stricture recurrences after endoscopic treatment do occur, however in most series the reported rate is low (Table 26.1), Tuvignon et al. [34], on the contrary reported a recurrence rate of 33.3 %. In this study, the persistence of a significant indentifica-

Table 26.1 Results of endoscopic management of postoperative bile duct strictures

Reference	Number of patients	Intervention type	Stenting duration months	Stricture recurrence %	Final success %	Length of follow-up (years)
Bergman et al. [27]	44	OC	NA	20.4	79.6	Median 9
Costamagna et al. [26]	35	MIXED	12	11.4	89	Mean 13.7
Kassab et al. [44]	65	LC	14	4.5	69	Mean 2.3
Kuzela et al. [45]	43	LC	12	0	100	Mean 1.3 ± 0.9
De Reuver et al. [35]	110	LC, OC	11	10	74	Mean 7.6 ± 2.9
Vitale et al. [46]	46	LC, OC	12	22	91	Mean 2.5 ± 2.0
Tuvignon et al. [34]	96	LC, OC	12	33.3	82.3	Median 6.1

LC laparoscopic cholecystectomy, *OC* open cholecystectomy, *MIXED:*, *LC*, *OC*, liver transplantation biliary anastomosis, hepatic trauma with biliary repair, *NA* not available tion of the bile duct on cholangiography at the time of stent removal was reported as a strong predictor factor of stricture recurrence. In a study by de Reuver et al. the independent predictors of outcome were the number of stents inserted during the first ERCP procedure, BDS classified as Bismuth III and IV, and endoscopic stenting before referral [35].

Canena et al. evaluated the cholangioscopic appearances of post-cholecystectomy BDS after endotherapy with an increasing number of plastic stents, and the predictive values of these appearances for the outcome [36]. The authors observed stricture recurrence only in patients in whom tissue hyperplasia was present at the end of a normal period of stenting with adequate calibration on cholangiography. Furthermore, after the second stenting protocol, there was resolution of epithelial hyperplasia in all cases. The authors concluded that the presence of hyperplastic tissue should be considered as a marker of instability and a logical predictor of active fibrosis of the bile duct stricture, which should lead to restricturing, despite a well-calibrated bile duct.

The main advantage of endotherapy with plastic stents is that strictures recurrences can be easily retreated endoscopically [26], and that in any case endotherapy does not preclude subsequent surgery, whereas hepaticojejunostomy, which is the classical surgical procedure, makes future endotherapy difficult, if not impossible.

As long as the use SEMS is concerned, the majority of the studies compares the outcomes of treatment with SEMS of benign biliary strictures due to various nature, including chronic pancreatitis, biliary anastomotic stricture, postoperative biliary strictures, sclerosing cholangitis, and autoimmune pancreatitis. [37–43]. Overall, results are promising but need further evaluation.

According to the ESGE guidelines, covered SEMS should be placed in selected patients with benign biliary strictures only as an investigational option [20]. Furthermore, SEMS cannot be placed in patients with post-LC BDS involving the hepatic hilum.

The role of SEMS in benign biliary strictures is not yet clearly defined due to variable results and small numbers, and is currently not recommended [20].

Conclusions

Endoscopy is in most instances the first-line treatment of injuries of the bile ducts occurring during LC. Sole biliary sphincterotomy with or without stones extraction and/or stent placement is the treatment of choice for the majority of bile leaks, whereas the “aggressive” plastic multistenting is the treatment of choice for BDS.

The use of fully covered SEMS for post-LC BDS is limited to carefully selected cases.

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