

Review Article

Post cholecystectomy bile duct injury: a surgeon's nightmare

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ABSTRACT

Bile duct injury constitutes a major proportion of morbidity associated with cholecystectomy (laparoscopic>open). It has a lot of impact on patient health and subsequent medico-legal repercussions. Anatomical aberrations in the Calot's triangle anatomy is more common than meets the eye. A thorough understanding of anatomy, identification of the variant structures, Use of intraoperative cholangiogram and low threshold for conversion to open procedure could prove life-saving in many cases. Optimal timing of intervention has to be planned once the type of injury is identified. Minor leaks are usually managed with endoscopic interventions. More proximal leaks and complete transaction of bile duct usually require Roux En Y hepaticojejunostomy. The principal is to ensure complete drainage of all segments and prevention of sepsis. More grave scenarios like concomitant vascular injury, segmental atrophy and secondary biliary cirrhosis require referral to a tertiary centre and subsequent multidisciplinary approach. The aim of the study was to establish the true incidence, classification and management of bile duct injuries that could be life - saving in a few cases and career- saving in many others.

Keywords: Bile duct injury, Critical view of safety, Hepatico-jejunostomy

INTRODUCTION

Bile leak or bile duct injury (BDI) after cholecystectomy has been a major problem even after decades since the first laparoscopic cholecystectomy was performed. In spite of increasing experience and technical refinements, the incidence of BDI is higher in laparoscopic cholecystectomy compared to open cholecystectomy. It has medical, economic, and legal implications. It can occur even in experienced hands, after one is past the so-called learning curve. So no one is immune to this dreaded complication and every effort should be made to prevent it.

Patients sustaining BDI during cholecystectomy have impaired quality of life and have higher morbidity and mortality as compared to those who have an uncomplicated cholecystectomy.^{1,2} There is a significant increase in health-care expenses associated with this

complication. It is one of the most common reasons for medical malpractice litigation. A study by B. Alkhaffaf revealed that bile duct injury was the most frequent injury resulting in litigation and the average payout for a successful claim was 102,827GBP/168,337 USD.³

The aim of this chapter is to review the factors responsible for BDI, ways to prevent it and management of the same, as and when it occurs.

POST-CHOLECYSTECTOMY BILE DUCT INJURY

Since Philippe Mouret performed the first laparoscopic cholecystectomy in 1987, it has been widely performed throughout the world and has become the gold standard for treatment of symptomatic gall stone disease.⁴ The incidence of BDI is higher as compared to open cholecystectomy (0.2% to 0.7% versus 0.1% to 0.3%).⁵

Laparoscopy-related BDI tend to be complex being more proximal and often associated with concomitant vascular injury.

MECHANISM OF INJURY

Several risk factors that predispose to BDI have been described which can be classified into anatomic factors, local pathology, technical factors and human cognitive psychology. Variations in the bilio-vascular anatomy such as short or tortuous cystic duct, aberrant biliary duct, aberrant right hepatic artery, caterpillar hump of cystic artery etc predispose to BDI with/without vascular injuries. Local pathology like acute cholecystitis, empyema GB, contracted GB, Mirrizi's syndrome, frozen Calot's triangle etc can pose difficulty in clearly defining the anatomy and can lead to BDI. Technical and surgeon related factors like inexperience, casual attitude towards a "simple gall bladder", inadequate or improper retraction, hasty and injudicious application of clamps or clips to arrest haemorrhage, overzealous use of electrocautery near the Calot's triangle and unnecessary attempt to demonstrate the junction of the cystic duct and the CBD increases the risk of BDI. It has been noted that maximum chances of BDI by a surgeon is between his 25th and 100th cholecystectomy.⁶

One important fact to be considered is that bile duct injuries occur mainly due to misperception and not merely due to errors of skill, knowledge or judgment. A study by Lawrence et al showed that the primary cause of error in 97% of cases was a visual perceptual illusion. Faults in technical skill were present in only 3% of injuries.⁶ Error traps as described by Strasberg et al increase the risks of BDI during cholecystectomy where during dissection of Calot's triangle in the setting of acute cholecystitis either by infundibular or fundus first method, due to inflammation and contracted positions of the structures in Calot's triangle the dissection proceeds medial to CHD/CBD and leads to injury as CHD/CBD are mistaken as cystic duct at the end of dissection.⁷ The other error traps are failure to perceive the presence of an aberrant right hepatic duct and parallel union of cystic duct. Whatever be the mechanism of injury, the impact of BDI is disastrous for both the patient and the operating surgeon, hence utmost care needs to be taken to prevent it.

THE CLASSICAL LAPAROSCOPIC BDI

A classic laparoscopic injury occurs when there is excessive cephalad retraction of the fundus of the gallbladder leading to cystic and common ducts being aligned in a single plane thereby causing CBD to be mistaken for the cystic duct. The surgeon, erroneously thinking the cystic duct has been divided, continues to dissect the common duct proximally and eventually transects the CHD to complete the cholecystectomy.⁸ The right hepatic artery (RHA) is also typically injured or ligated because of its proximity. These are the most

complex injuries as they are proximal and often associated with vascular injury.

PREVENTION OF BDI

The phrase 'prevention is better than cure' is apt in this setting. The following points should always be kept in mind while performing a laparoscopic cholecystectomy. Critical view of safety, only two structures (cystic duct and artery) entering the GB with the liver in the background, should be demonstrated in all cases before clipping. Overzealous use of electrocautery near the Calot's triangle should be avoided. Hasty and injudicious application of clamps or clips to arrest haemorrhage should be avoided. Extensive dissection around the CBD should not be done as it may damage its axial blood flow leading to ischemic damage to the duct and late stricture formation. Excessive traction can lead to the tenting of the CBD and hence should be avoided. Unnecessary attempt to demonstrate the junction of the cystic duct and the CBD should not be promoted. In 'difficult gallbladder', subtotal cholecystectomy can be adopted. There should be no hesitation in converting to open procedure in case of difficult dissection and unclear anatomy. The surgeon should know when to stop and call for help/expert opinion. It should always be remembered that conversion to open cholecystectomy should not be regarded as a failure but rather a necessary measure to prevent disastrous biliovascular complications.

USE OF INTRA-OPERATIVE CHOLANGIOGRAM

Though stressed by many authors, the routine use of intraoperative cholangiogram (IOC) still remains controversial. Though it does not prevent an injury, it does help the surgeon to identify it early and an on-table repair can be attempted if feasible. Archer et al reported that 81% of bile duct injuries were detected at the time of index surgery when a cholangiogram was performed in comparison to only 45% when it was not.⁹ It is not commonly done as routine use of IOC does not have a significant practical advantage. If all precautions mentioned earlier are followed, IOC may not have a significant role in reducing BDI.

CLASSIFICATION OF BDI

There are many classification systems that have been described and the most commonly followed ones are mentioned here. Most systems describe a spectrum ranging from minor cystic duct leaks to complete transection of major ducts with or without a concomitant vascular injury. Although many of these classifications are used for reporting the level of injury and guiding management decisions, there is no ideal system. They have the fallacy of excluding the mode of presentation, attempts at previous repair, presence of concomitant sepsis and stability of the patient which have a significant bearing on the final outcome. Other factors like associated vascular

injuries, presence of secondary biliary cirrhosis, portal hypertension are also not routinely included in the present classification systems.

Table 1: Bismuth classification of BDI.¹⁰

Types	Criteria
1	Low common hepatic duct (CHD) stricture/injury, length of CHD stump ≥ 2 cm.
2	Proximal CHD stricture/injury, CHD stump < 2 cm.
3	Hilar stricture/injury, no residual CHD but the hepatic ductal confluence is preserved
4	Hilar stricture/injury, with involvement of confluence and loss of communication between right and left hepatic duct
5	Involvement of aberrant right hepatic duct alone or concomitantly with CHD

This system has the advantage of being simple, universally acceptable and has good correlation with final outcome after surgical repair. The same classification can be used for both BDI and strictures. The main fallacy is that it includes only major duct injury and doesn't include concomitant vascular injury.

Table 2: Strasberg classification of BDI.¹¹

Types	Criteria
A	Leak from cystic duct or bile duct of Luschka
B	Occlusion of aberrant right hepatic duct
C	Transsection without ligation of aberrant right hepatic duct
D	Lateral injury to major bile duct
E	Subdivided per the bismuth classification into E1-E5

Used widely to describe the type of acute BDI and includes both major and minor duct injuries and helps in management decisions according to type.

Table 3: Stewart-way classification of BDI.¹²

Class	Criteria
I	CBD mistaken for cystic duct, but recognized on cholangiogram; incision in cystic duct extended on to CBD
II	Bleeding, poor visibility. Multiple clips placed on CBD/CHD
III	CBD mistaken for cystic duct, not recognized. CBD, CHD, or right or left hepatic ducts transected and/or resected
IV	Right hepatic duct (or right sectoral duct) mistaken for cystic duct RHA mistaken for cystic artery. Right hepatic duct (or right sectoral duct) and RHA transected.

This classification was mainly designed for laparoscopic BDI. The mechanisms and possible reasons for various classes of have been explained and biliovascular injuries also have been included.

Table 4: Hannover system.¹³

Types	Criteria
A	Cystic and/or gallbladder bed leaks
B	Complete or incomplete stenosis caused by a surgical staple
C	Lateral tangential injuries
D	Complete transection of the CBD emphasizing the distance from the confluence as well as concomitant hepatic artery and portal vein injuries
E	Late bile duct stenosis at varying distances from the confluence

This system classifies injuries in relationship to the confluence and also includes vascular injuries. It is reproducible and ensures uniformity of reporting.

CLINICAL PRESENTATION

The clinical presentation and management is based on the timing of recognition of injury, the extent of BDI, the patient's hemodynamic stability and the availability of expertise at that centre.¹⁴ The various stages of detection of BDI are discussed here.

BDI DETECTED INTRA-OPERATIVELY

Recognition of BDI at the time of initial surgery is extremely important to avoid the increased future morbidity and mortality but unfortunately only 20-30% of these injuries are detected intra-operatively. The signs suggestive of a BDI are presence of golden yellow bile in operative field, retraction of the divided duct (presumed to be cystic duct) behind the duodenum, inability to dissect off the GB from its bed after division of presumed cystic duct.

WHAT TO DO?

If a BDI is suspected intra-operatively, dissection should not be continued further, video if available should be reviewed and help/second opinion should be called for. Procedure should be converted to open to identify the injury correctly and repairing it if expertise is available. Intra-operative cholangiogram is a very useful tool in such situations. The details of surgical repair would be discussed later.

PRESENTATION IN THE EARLY POSTOPERATIVE PERIOD

Another 20-25% of BDIs present in the early post-operative period, commonly within 3-5 days of index

surgery.^{6,14} The manifestation of such injuries depends on the presence or absence of intra-peritoneal drains and biliary peritonitis being localised or generalised. Patients in whom drains have been placed intra-operatively may present with bile leak through the drain with or without sepsis depending on the adequacy of drainage of intra-abdominal collections via the drains.

Very high index of suspicion is required in patients with BDI without drains as the initial symptoms can be non-specific like malaise, nausea, abdominal pain, low grade fever. If not identified early they may progress to generalized peritonitis and sepsis leading to high morbidity and mortality. Persistent high bile output through the drains in the early postoperative period is suggestive of a major bile duct injury whereas serially decreasing output may be considered due to minor bile duct/cystic duct leak. Neglected cases may present later with bilioma or external biliary fistula (EBF).

Bilioma and biliary peritonitis

Localized collection of bile in the peritoneal cavity is known as bilioma and free leakage into peritoneal cavity known as biliary peritonitis. When bile is non-infective it does not evoke an inflammatory reaction hence patient does not have features of peritonitis and may have only non-specific symptoms like abdominal pain, vomiting, abdominal distension. Patients may present with peritonitis and sepsis when the bile is infected specially in the absence of drains, and carries high mortality rates. There may be presence of jaundice due to absorption of bile from peritoneal cavity.⁶

External biliary fistula

It is defined as an abnormal communication between biliary tract and abdominal wall (Figure 1). It can be either a high output (>500 ml/day) or low output (<500 ml/day) fistula. The other way to classify is controlled or uncontrolled fistula. In controlled fistula, there is adequate drainage of bile through drains or the fistulous communication without any significant intra-abdominal collection whereas in uncontrolled fistula it is the other way round leading to localised or generalised peritonitis with sepsis. Majority of EBF as a result of partial bile duct injury closes over a period of time (6-8 weeks) while those due to major bile duct injury persist. Persistent high output fistula lead to fluid and electrolyte imbalances along with fat soluble vitamins deficiency. Long standing case may also have protein and calorie malnutrition.

Bile duct clipping without bile leak

This comprises of an interesting entity, where the patient presents early with obstructive jaundice without bilioma or peritonitis. There is a definite role for early surgery in this subset of patients. Strasberg type B injury also is also included here and is asymptomatic most of the times, but

may present later with segmental cholangitis or lobar atrophy.

LATE PRESENTATION

The healing of BDI occurs by the process of fibrosis and scar formation. Scar contracture leads to formation of biliary stricture, the patient presenting with painless progressive obstructive jaundice. About 30-60% of the BDIs will develop strictures requiring intervention.



Figure 1: Post cholecystectomy bile leak through intra-abdominal drain.

EVALUATION

The role of initial evaluation is to assess the hemodynamic stability of the patient and to rule out localised or generalised peritonitis, vascular injury, which may require urgent intervention.

The second step would be to identify the type and extent of injury and plan further treatment. The management depends on the timing of recognition of injury, extent of BDI, presence of sepsis or biliary peritonitis and availability of expertise.

INVESTIGATIONS

Complete blood picture, liver function tests, renal function tests are the important parameters in the initial evaluation of BDI. Low haemoglobin and increased TLC may indicate vascular injury and sepsis. Rapidly rising bilirubin and alkaline phosphatase are markers of complete clipping of CBD/CHD. Bilirubin may also rise due to absorption of bile by peritoneal surface. Patients may have acute renal failure as a component of sepsis. Patients with BDI with sepsis and multiorgan failure have high mortality.

Ultrasonography

It is the most commonly performed initial investigation for BDI being easily available, non-invasive and cost effective. It gives valuable information about the presence of intra-abdominal collections, CBD/IHBR dilation,

retained CBD stones etc. However the sensitivity is less in the presence of dilated bowel loops and it is operator dependent. The main use of USG is to detect intra-abdominal collections and guided percutaneous drainage of these collections.

Computed tomography scan

Computed tomography (CT) scan has definite advantage over USG in providing detailed information on intra-abdominal collection (Figure 2), level and extent of biliary injury, associated vascular injury and liver ischemia. CT can help in planning the management better. Patients with multiple loculated collections on CT may benefit more with laparotomy/laparoscopic lavage rather than percutaneous drainage.¹⁴

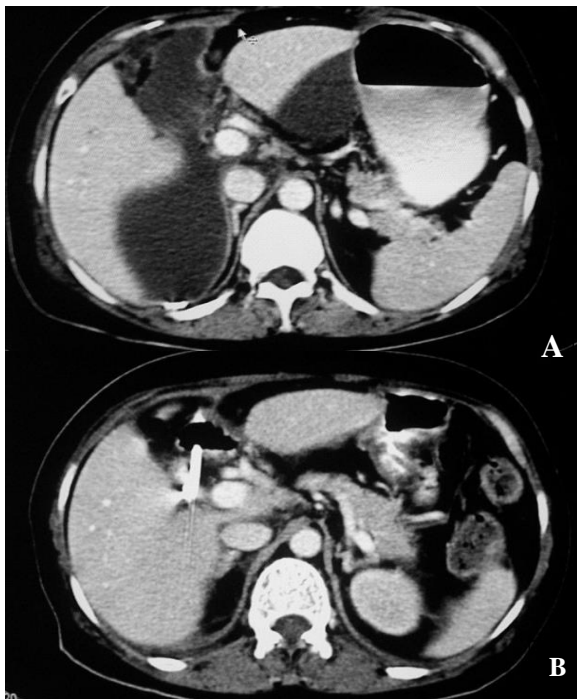


Figure 2: CT abdomen showing (a) intra-abdominal collection; and (b) post-percutaneous drainage of collection.

MRI with MRCP

It is the gold standard for assessment of biliary tract anatomy and anomalies. It is an extremely useful modality in determining the type and extent of BDI and associated vascular injuries. Prerequisite before performing MRCP is to drain the intra-abdominal collections adequately as they can produce artefacts.

MRCP being non-invasive can be performed in patients even with deranged renal functions. It is more suited in patients with proximal injuries with undilated ducts. It can detect the continuity of the bile ducts (CHD/CBD) and retained CBD stones/distal stricture thereby aiding in

selection of this subset of patients with BDI amenable to endoscopic therapy.¹⁴

Percutaneous transhepaticcholangiogram

In the era of MDCT and MRCP, Percutaneous transhepaticcholangiogram (PTC) has limited role as a diagnostic modality. It can be done when ERCP and MRCP fail to demonstrate the biliary anatomy clearly. The main indication is to guide the placement of percutaneous biliary drainage catheter into the undrained liver segments in patients with cholangitis.

Cholangiogram can be obtained in the same setting for delineating the biliary system. These catheters may serve as guides during definitive surgery to identify proximal ducts. The disadvantages of PTC are that it is an invasive procedure with complications like bleeding, pericatheter bile leak and increased patient morbidity.

Scintigraphy

Hepatic iminodiacetic acid (HIDA) scan is helpful in the diagnosis of bile leak where other imaging modalities do not show significant collection suggestive of BDI. It may also identify isolated bile duct (Strasberg type B) injury as hold up of contrast in particular liver segments. However it is not routinely used in the diagnosis of BDI as it lacks specificity in relation to biliary anatomy.

MANAGEMENT

Early and accurate detection, interventions to control sepsis, biliary peritonitis and bleeding are the foremost priorities in management of BDI. It requires a multidisciplinary approach which includes interventional radiologist, endoscopists and surgeons, to achieve the best results. In case the patient has been referred from another hospital, it is prudent to review the operating notes and talk to the primary surgeon if possible. The patients and their relatives should be given accurate information about the present condition and the future course of action and clear documentation in medical records is must. It is very important to realise at this juncture that “complication is not a medical negligence; but bad management of a complication is”. As already mentioned earlier, the management depends on the timing of recognition of injury, extent of BDI, presence of sepsis or biliary peritonitis and availability of expertise.

BDI detected intra-operatively

Any BDI which is recognised intra-operatively is best managed by immediate repair.¹⁵ The prerequisites are hemodynamic stability of the patient and availability of expertise.

Since the first attempt at repair is the best attempt, it should be performed by a specialist surgeon as subsequent repairs become more and more difficult and demanding. Repair by

expert specialist surgeons have excellent long term outcomes as compared to amateur surgeons.

When expertise is not available

In most of the instances expertise for reconstruction is not available and in such situations the primary surgeon should not be tempted to repair the injury. Repairs done by inexperienced surgeons are likely to fail and the subsequent repair may be much more difficult to perform. No half-hearted repairs should be done as “*a poorly performed repair greatly exacerbates an already difficult situation*”.

When expertise to repair is not immediately available, the best option (in the interest of both the patient and surgeon) is to thoroughly lavage the peritoneal cavity, record the operative findings and place wide bore drains in the sub-hepatic fossa which will ensure a controlled external biliary fistula, thus preventing peritoneal sepsis.¹⁶ A t-tube or feeding tube can be inserted into the duct. This can be performed laparoscopically if feasible or a conversion to laparotomy is justified. No attempt should be made to clip or ligate the divided duct as it leads to proximal migration of level of injury due to ischemia and necrosis. The next step is to correctly explain the patient's attenders about the event and the need to refer the patient to a centre where expertise is available. No attempts should be made to conceal any facts from the attenders and the same should be entered in the medical records.

Impact of timing of referral

Variability in timing of referral of BDI to tertiary centres has been noted in the literature.

Fischer et al in their study showed that patients referred after 72 hours of recognition of BDI were more likely to have intra-abdominal collections and prolonged ICU stay after definitive repair, when compared with patients referred within 72 hours. Hence the policy of early referral to centres with expertise, minimization of the number and invasive nature of pre-referral procedures to only those that ensure the safety of transfer is recommended.¹⁷

When expertise is available

A trained biliary surgeon with adequate experience in reconstructive biliary surgery should ideally do the repair. The procedures should be converted to an open operation and repair done according to the type of injury.

A lateral/incomplete injury (involving partial circumference of the duct) may be repaired with fine (4-0/5-0) vicryl/PDS sutures. Some authors have recommended repair over a T tube.¹⁸ However, the prerequisites for a primary repair are CBD should be clearly identifiable without extensive damage or tissue loss or impairment of blood supply and no evidence of local inflammation or sepsis. There should be no loss of length

producing tension in repair. However primary repairs are associated with high rates of late strictures.

The gold standard management of a complete transection of the bile duct is the restoration of the biliary enteric continuity with a Roux-en-Y hepaticojejunostomy.^{16,18} When the bile duct has been divided without segment loss, a primary end to end anastomosis of the cut ends of bile duct can be attempted but is not preferred by most biliary surgeons as almost half of such repairs developed into strictures that later required hepaticojejunostomy.¹⁹ At this juncture we should remember that only one-third of the injuries are recognised intra-operatively and majority of them manifest in the early post-operative period. The real challenge is to treat these patients.

Selection of patients for percutaneous, endoscopic or surgical management

In the management of post-cholecystectomy BDI, interventional radiologists, endoscopists, and surgeons play a complementary rather than competing roles. The initial presenting features of this subset of patients has been described earlier. Before deciding on any mode of intervention, it is important to determine the patient's general and hemodynamic condition, the type of injury, presence of peritonitis and the expected benefits and risks in the light of the published results of these various interventions in literature till date.

Presence of peritonitis warrants surgical intervention in the form of thorough lavage and drain placement by laparoscopy or laparotomy with the objective of containing systemic sepsis. In case of bilioma or localized collections without features of peritonitis image-guided percutaneous catheters can be used to obtain drainage and establish a controlled external biliary fistula. Once patient is optimized adequately, imaging is done to identify the type of injury and further intervention is planned accordingly.

In class A injuries, ERCP and biliary stenting has a very high success rate and is the treatment of choice.²⁰ Class B injuries may remain asymptomatic or present late with atrophy-hypertrophy complex and sectoral cholangitis which may require hepatectomy later in some cases. An isolated sectoral duct injury may present with ongoing biliary leak (class C) despite a normal ERC which can be diagnosed with a HIDA scan.²¹ In such situations percutaneous drainage of the isolated segment allows proximal control of the biliary leak in most of the cases.²¹

In patients who require surgery, hepaticojejunostomy (HJ) is the treatment of choice and the catheter acts as guide at the time of surgery.^{22,23} For class D injuries without tissue loss, primary closure with fine absorbable sutures and sub-hepatic drainage is a feasible option, though the late stricture formation rates are higher. But since most of these strictures are type I and II, endoscopic dilatation and stenting is a reasonably good option for such patients. In

patients with significant loss of duct tissue, HJ is the preferred option, although end to- end repair may be considered in select cases.²⁴ Surgical repair is indicated for injuries with complete transection of the bile duct and for most E4 and E5 injuries.

Early verses delayed surgical repair

The timing of bile duct repair (early/late) of post cholecystectomy BDI is still a matter of debate. It is determined by the general condition of the patient, ongoing sepsis/peritonitis and expertise of the operating surgeon.

Although the best chance for a repair involves the subset of patients with injuries detected during surgery, in the vast majority of the cases the surgeon causing the injury has not enough experience to perform the repair.

If expertise is unavailable, transfer of the patient should be considered after adequate drainage is achieved by large bore drains. In the presence of disruption of the confluence with an associated vascular injury, significant diathermy injury, or surrounding sepsis delayed repair is advisable. In the presence of a biliary fistula there is no consensus on timing of repair. It is better to wait for 3 to 6 months during which inflammation is likely to subside and the fistula is likely to close/get controlled without an undue risk of secondary biliary cirrhosis.

Delayed repair has shown excellent long-term outcomes with a very low risk of mortality.²⁵ If the patient's condition is optimal and the repair is performed at an experienced center, both early and delayed repair have comparable long-term outcomes though early repair can result in significant cost savings, with decreased morbidity, mortality, hospital stay and number of outpatient visits.

Who should repair?

Surgical repair of a BDI may be technically challenging and it has been shown that this surgery should be best performed in hepatobiliary centres by experts.

Stewart and Way in their article described that only 17% of repairs were successful in those performed by a non-specialist surgeon compared with 94% of those performed by a specialist, and the hospital stay was three times longer when managed by a non-specialist surgeon (78 verses 222 days).

The morbidity and mortality of those treated by a non-specialist compared with specialist was 58% and 1.6% verses 4% and 0%, respectively.¹⁵

Choice of repair

Rouxen-Y (Figure 3) is the gold standard for the reconstruction of bile ducts. It should be tension free,

single-layer anastomosis to healthy non-inflamed bile duct mucosa with absorbable sutures.

To ensure an adequate length of anastomosis, the left hepatic duct can be exposed along its extra-hepatic course at the base of segment 4.¹⁵



Figure 3: Type III BDI- both right and left duct opened to do a wide anastomosis.

Biliovascular injuries (Figure 4)

Strasberg and Helton described the pathophysiology of concurrent biliary and vascular injury in a review.²⁶ In published series on BDI following LC, concomitant injury of a hepatic artery has been reported in 12% to 40% of patients.²⁶⁻²⁸ Around 10% of patients with RHA injury develop hepatic infarction.²⁶

In case of disruption of compensatory collateral flow through marginal arteries and hilar shunt by a high BDI, there is a risk of exacerbation of hepatic ischemia when the RHA is occluded.²⁶

High injuries and vascular injuries are a risk factor for hepatectomy for BDI.^{29,30} Patients with combined arterial and Strasberg E4 or E5 injury were 43.3 times more likely to undergo hepatectomy than patients without complex injury.³⁰ In contrast, when the hilar arcade is preserved and the ischemic stricture has demarcated, a delayed repair by a specialist has good outcomes even in the presence of arterial injury.

A prospective study by Alves et al showed no difference in outcome between those with and without arterial injury.²⁸ Hence, unless associated with massive hepatic necrosis, RHA injury following cholecystectomy does not have significant bearing on the outcome of biliary injury if a delayed repair is performed. Biliovascular injury associated with sepsis is an adverse prognostic factor.³¹

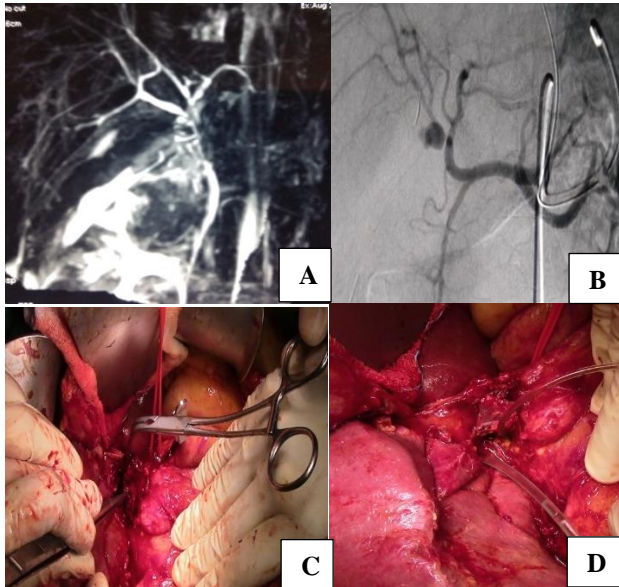


Figure 4: Biliovascular injury (A) MRCP showing E4 BDI associated with; (B) RHA injury with pseudoaneurysm (arrow); (C) RHA being ligated; and (D) drains placed in sub-hepatic space to create a controlled external biliary fistula.

CONCLUSION

‘Prevention is better than cure’ fits aptly in the setting of post cholecystectomy BDI. The importance of safe surgery to minimize BDI cannot be overemphasized. In case it happens, proper documentation and communication with the patient’s attenders is of utmost importance. Diagnosis requires a high index of suspicion aided by clinical, biochemical and radiological examination. Widely accepted classification systems include the bismuth and Strasberg systems which help to classify and plan treatment strategy. Irrespective of the modality of treatment chosen, the initial strategy is to control sepsis and bleeding. ERC stenting is the treatment of choice for class A injuries and has a role in select cases of class D injuries where biliary continuity is maintained without much tissue loss. Aberrant right hepatic duct injuries without and with a leak (classes B and C) are managed according to the timing and severity of their presentation and can be challenging to diagnose and treat and may require hepatectomy in cases of persistent segmental cholangitis. The gold standard for the treatment of class E injuries is a Roux-en-Y HJ with literature evidence to support long-term excellent outcomes both for early and delayed repairs when performed by a specialist. Combined high biliovascular injuries are associated with a poorer

outcome. To summarise the management of post cholecystectomy BDI should be multidisciplinary approach based protocol following a structured algorithm, providing the best possible treatment based on evidence to suit individual patient circumstances.

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REFERENCES

- Gossage JA, Forshaw MJ. Prevalence and outcome of litigation claims in England after laparoscopic cholecystectomy. *Int J Clin Pract.* 2010;64(13):1832-5.
- Gigot J, Etienne J, Aerts R, Wibin E, Dallemagne B, Deweer F, et al. The dramatic reality of biliary tract injury during laparoscopic cholecystectomy. An anonymous multicenter Belgian survey of 65 patients. *Surg Endosc.* 1997;11(12):1171-8.
- Alkhaffaf B, Decadt B. 15 years of litigation following laparoscopic cholecystectomy in England. *Ann Surg.* 2010;251(4):682-5.
- Soper NJ, Stockmann PT, Dunnegan DL, Ashley SW. Laparoscopic cholecystectomy. The new 'gold standard'? *Arch Surg.* 1992;127(8):917-21.
- Flum DR, Cheadle A, Prella C, Dellinger EP, Chan L. Bile duct injury during cholecystectomy and survival in medicare beneficiaries. *JAMA.* 2003;290(16):2168-73.
- Way LW, Stewart L, Gantert W, Liu K, Lee CM, Whang K, et al. Causes and prevention of laparoscopic bile duct injuries: analysis of 252 cases from a human factors and cognitive psychology perspective. *Ann Surg.* 2003;237(4):460-9.
- Strasberg SM. Error traps and vasculo-biliary injury in laparoscopic and open cholecystectomy. *J Hepatobiliary Pancreat Surg.* 2008;15(3):284-92.
- Davidoff AM, Pappas TN, Murray EA, Hilleren DJ, Johnson RD, Baker ME, et al. Mechanisms of major biliary injury during laparoscopic cholecystectomy. *Ann Surg.* 1992;215(3):196-202.
- Archer SB, Brown DW, Smith CD, Branum GD, Hunter JG. Bile duct injury during laparoscopic cholecystectomy: results of a national survey. *Ann Surg.* 2001;234(4):549-58.
- Bismuth H. Postoperative strictures of the bile duct. In: Blumgart LH, eds. *The Biliary Tract.* Edinburgh: Churchill Livingstone; 1982: 209-218.
- Strasberg SM, Hertl M, Soper NJ. An analysis of the problem of biliary injury during laparoscopic cholecystectomy. *J Am Coll Surg.* 1995;180(1):101-25.

12. Stewart L, Robinson TN, Lee CM, Liu K, Whang K, Way LW. Right hepatic artery injury associated with laparoscopic bile duct injury: incidence, mechanism, and consequences. *J Gastrointest Surg.* 2004;8(5):523-30.
13. Bektas H, Schrem H, Winny M, Klempnauer J. Surgical treatment and outcome of iatrogenic bile duct lesions after cholecystectomy and the impact of different clinical classification systems. *Br J Surg.* 2007;94(9):1119-27.
14. Bharathy KG, Negi SS. Postcholecystectomy bile duct injury and its sequelae: pathogenesis, classification, and management. *Indian J Gastroenterol.* 2014;33(3):201-15.
15. Stewart L, Way LW. Bile duct injuries during laparoscopic cholecystectomy. Factors that influence the results of treatment. *Arch Surg.* 1995;130(10):1123-8.
16. Kapoor VK. Bile duct injury repair: when? what? who? *J Hepatobiliary Pancreat Surg.* 2007;14(5):476-9.
17. Fischer CP, Fahy BN, Aloia TA, Bass BL, Gaber AO, Ghobrial RM. Timing of referral impacts surgical outcomes in patients undergoing repair of bile duct injuries. *HPB (Oxford).* 2009;11(1):32-7.
18. Csendes A, Navarrete C, Burdiles P, Yarmuch J. Treatment of common bile duct injuries during laparoscopic cholecystectomy: endoscopic and surgical management. *World J Surg.* 2001;25(10):1346-51.
19. Sicklick JK, Camp MS, Lillemoe KD, Melton GB, Yeo CJ, Campbell KA, et al. Surgical management of bile duct injuries sustained during laparoscopic cholecystectomy: perioperative results in 200 patients. *Ann Surg.* 2005;241(5):786-92.
20. Fatima J, Barton JG, Grotz TE, Geng Z, Harmsen WS, Huebner M, et al. Is there a role for endoscopic therapy as a definitive treatment for post-laparoscopic bile duct injuries? *J Am Coll Surg.* 2010;211(4):495-502.
21. Perera MT, Monaco A, Silva MA, Bramhall SR, Mayer AD, Buckels JA, et al. Laparoscopic posterior sectoral bile duct injury: the emerging role of nonoperative management with improved long-term results after delayed diagnosis. *Surg Endosc.* 2011;25(8):2684-91.
22. Li J, Frilling A, Nadalin S, Radunz S, Treckmann J, Lang H, et al. Surgical management of segmental and sectoral bile duct injury after laparoscopic cholecystectomy: a challenging situation. *J Gastrointest Surg.* 2010;14(2):344-51.
23. Lillemoe KD, Petrofski JA, Choti MA, Venbrux AC, Cameron JL. Isolated right segmental hepatic duct injury: a diagnostic and therapeutic challenge. *J Gastrointest Surg.* 2000;4(2):168-77.
24. Jabłońska B, Lampe P, Olakowski M, Górka Z, Lekstan A, Gruszka T. Hepaticojejunostomy vs. end-to-end biliary reconstructions in the treatment of iatrogenic bile duct injuries. *J Gastrointest Surg.* 2009;13(6):1084-93.
25. Kapoor VK. Management of bile duct injuries: a practical approach. *Am Surg.* 2009;75(12):1157-60.
26. Strasberg SM, Helton WS. An analytical review of vasculobiliary injury in laparoscopic and open cholecystectomy. *HPB (Oxford).* 2011;13(1):1-14.
27. Li J, Frilling A, Nadalin S, Paul A, Malagò M, Broelsch CE. Management of concomitant hepatic artery injury in patients with iatrogenic major bile duct injury after laparoscopic cholecystectomy. *Br J Surg.* 2008;95(4):460-5.
28. Alves A, Farges O, Nicolet J, Watrin T, Sauvanet A, Belghiti J. Incidence and consequence of an hepatic artery injury in patients with postcholecystectomy bile duct strictures. *Ann Surg.* 2003;238(1):93-6.
29. Li J, Frilling A, Nadalin S, Broelsch CE, Malago M. Timing and risk factors of hepatectomy in the management of complications following laparoscopic cholecystectomy. *J Gastrointest Surg.* 2012;16(4):815-20.
30. Truant S, Boleslawski E, Lebuffe G, Sergent G, Pruvot FR. Hepatic resection for post-cholecystectomy bile duct injuries: a literature review. *HPB (Oxford).* 2010;12(5):334-41.
31. Sarno G, Al-Sarira AA, Ghaneh P, Fenwick SW, Malik HZ, Poston GJ. Cholecystectomy-related bile duct and vasculobiliary injuries. *Br J Surg.* 2012;99(8):1129-36.

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