Original Article

Bile duct injuries following laparoscopic cholecystectomy and repair involving lowering of the hilar plate

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ABSTRACT

Background: Laparoscopic cholecystectomy (LC) is the standard of care for symptomatic cholelithiasis, but is associated with a higher incidence of bile duct injuries than the open approach. We evaluated a multidisciplinary approach for managing these injuries after LC. **Materials and Methods:** From April 2006 to August 2011, all patients who developed bile duct injury after LC and were treated by the hepatobiliary team of Al-Hada Armed Forces Hospital, Taif, Saudi Arabia were included in our study. If an injury was suspected intraoperatively, intraoperative cholangiography was performed; thereafter, if the injury was confirmed, immediate laparotomy and primary repair or hepaticojejunostomy (H-J) involving lowering of the hilar plate were performed. Injuries occurring postoperatively were treated by endoscopic cholangiopancreatography (ERCP) to diagnose the type of Strasberg injury. Strasberg type A injuries were managed endoscopically, and more advanced cases underwent open surgery. **Results:** Of 30 females and 18 males (mean age, 45 years; range, 18–90 years), 6 cases of bile duct injuries were discovered intraoperatively. Of these, two were classified as type C and underwent primary repair with internal stenting. The other four were classified as type E and were treated by Roux-en-Y H-J reconstruction. Forty-two cases of bile duct injuries presented postoperatively, including 18 Strasberg type A and 24 Strasberg type E injuries. Type A injuries were treated with ERCP and stenting, and six with endoscopic removal of a retained stone. Of the 28 patients who underwent H-J, 20 underwent the technique involving lowering of the hilar plate. Of these, three subsequently developed anastomotic strictures and were treated with percutaneous transhepatic balloon dilatation. There were no mortalities. The mean follow-up was for 36 months. **Conclusion:** Early referral to a specialized surgeon and a multidisciplinary approach help manage bile duct injury after LC in all patients with an acceptable low stricture rate.

Key Words: Bile duct injury, cholecystectomy, endoscopic cholangiopancreatography, hepaticojejunostomy, intraoperative cholangiogram, lowering of the hilar plate

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Introduction

Laparoscopic cholecystectomy (LC) was introduced more than a century after the first open cholecystectomy was done by Carl Langenbuch in 1882. Since then, LC has become the most commonly performed operation in the digestive tract.[1] However, LC is associated with a higher incidence of bile duct injury compared to open cholecystectomy, and the incidence of bile duct injury associated with LC has risen from about 0.15% to 0.6%.[1,2] Only 30% of injuries are identified intraoperatively, and the majority present postoperatively with non-specific symptoms.[3,4] Various classification systems have been developed to anatomically describe bile duct injuries in order to facilitate decision making regarding the treatment options. Bismuth[5] proposed a system that was widely used during the era of open cholecystectomy, which was

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subsequently modified by Strasberg[6] and his colleagues to a more comprehensive system to account for the injury patterns observed with LC; however, these classification systems did not consider possible associated vascular injuries, which were added by Stewart-Way[7] and more recently modified by Lau and Lai.[8] Bile duct injuries with vascular involvement may result in abscess formation, secondary biliary cirrhosis, or acute hepatic necrosis, and even require liver transplantation.[9-11] The initial evaluation of a suspected bile duct injury depends on the imaging techniques employed, such as ultrasonography and computed tomography (CT). In addition, endoscopic cholangiopancreatography (ERCP) can confirm the presence of a biliary injury and can facilitate the definitive management of many different types of injuries with temporary internal stents.[12,13] Optimal management of a bile duct injury depends on not only the extent and location of the injury but also the time at which the injury is recognized. An initial repair by a qualified hepatobiliary surgeon experienced in bile duct reconstruction provides the best opportunity for an optimal outcome, as salvage repair for a secondary stricture after the initial reconstruction has a poorer outcome. However, if an expert surgeon is unavailable, referral to a tertiary care hospital allows for a multidisciplinary management approach, as inadequate treatment may lead to severe complications.[14,15]

The current nationwide magnitude of bile duct injury is not known, and very few studies have described this issue. In the present study, we aimed to study the pattern of presentation of bile duct injury in Taif, Saudi Arabia, and to evaluate a single-center experience with a multidisciplinary approach for the management of bile duct injuries following LC.

Materials and Methods

In this study, we describe the data obtained from all patients treated by the hepatobiliary team of Al-Hada Armed Forces Hospital, Taif, Saudi Arabia, between April 2006 and August 2011. We also assessed the patients who were transferred to our hospitals after the injury was detected intraoperatively and also those who were transferred to our center for continuous follow-up. Alternatively, if the injury was recognized late (i.e. postoperatively), a formal consultation and transfer to our center was performed to initiate the examination and management of the patient. Of the 28 patients who underwent hepaticojejunostomy (H-J), 3 (11%) had their injuries in our hospital. These were all recognized intraoperatively because of difficulty during the operation and the use of intraoperative cholangiography (IOC). Also, 16 (89%) of the type A injuries occurred in our hospital and they were treated by ERCP, as these are simpler to resolve and are usually not referred to higher centers for treatment. If intraoperative injury was suspected, IOC was performed. If the presence of the injury was confirmed, immediate laparotomy was performed with primary repair around a stent; however, more complex injuries were treated with Roux en-Y H-J. Cases of postoperative bile duct injuries (late presentation) were initially treated with appropriate antibiotics, and all the cases were subjected to a full clinical evaluation including liver function tests (LFT) and abdominal ultrasonography. If fluid collection was detected in cases where no drain was inserted, the fluid was drained by ultrasonography-guided aspiration (USGA) and the patient was then treated by ERCP in order to diagnose the type of injury according to the Strasberg classification. Type A cases were managed endoscopically, whereas more advanced injuries were treated by open surgery after Roux en-Y H-J. Triphasic CT was performed in all cases to assess any associated vascular lesions. A drain was retained in all the patients and removed after 5 days when there was no bile leak. Postoperative follow-up involving clinical, ultrasonography, and liver function evaluation was completed for all patients. Patients were followed up every 3 months.

From 2006 till the end of December 2007, we used the end-to-side H-J technique in all patients' repair, which comprised the first group. Since 2008, we had used the newly developed technique involving right end-to-side with left side-to-side Roux en-Y H-J with lowering the hilar plate;[16] these patients comprised the second group.

The study was approved by the local committee on human research in Al-Hada Armed Forces Hospital.

Results

Of the 48 patients with bile duct injuries following LC, there were 30 females (62.5%) and 18 males (37.5%); the mean age was 42 years in the females (range, 18-84 years) and 48 years in the males (range, 41-90 years). Of the six cases of intraoperative bile duct injury [Table 1], 2 (4.2%) were Strasberg type C injuries and were treated

Table 1: Bile duct injuries detected intraoperatively

Injuries	Number (%)	Management
All injuries	6/48 (12.5%)	Open laparotomy and immediate reconstruction
Strasberg type C	2/6 (33.3%)	Primary repair with internal stenting
Strasberg type E2	1/6 (16.7%)	Roux-en-Y H-J
Strasberg, type E3	2/6 (33.3%)	
Strasberg type E4	1/6 (16.7%)	

by primary repair over an internal stent [Figure 1]; the other four patients underwent Roux-en-Y H-J. Forty-two (87.5%) cases presented with bile duct injuries postoperatively [Table 2]. In the late presentation group [Table 3], all cases with type A injuries were managed by USGA if no drain was inserted and 6 (12.5%) patients also underwent endoscopic removal of the retained stones with stenting [Figure 2]. One patient experienced a persistent biliary leak originating from the gallbladder bed for 2 weeks that ultimately required surgical intervention. Roux-en-Y H-J was performed in the remaining 24 patients. The total number of H-Js performed was 28 (58.3%) [Figure 3]. The drain was retained for > 5 days in 7 (25%) patients; however, none of these patient required reoperation.

Pre-evaluation CT showed that one patient had a right hepatic artery aneurysm. He underwent embolization followed by H-J. However, after 6 months, he presented with upper gastrointestinal bleeding from the duodenum where the aneurysm opened into the duodenum. He underwent reoperation with ligation of the artery and ligation of the gastroduodenal artery. Of the 28 patients in the H-J group, 3 (10.6%) patients subsequently developed anastomotic strictures. Of the eight patients in the first group, 2 (25%) were treated with end-to-side anastomosis. Moreover, of the 20 patients in the second group, 1 (5%) underwent side-to-side anastomosis. All patients were successfully treated with percutaneous transhepatic balloon dilatation. There were no mortalities. The mean duration of follow-up was 36 months (range, 13-66 months).

Table 2: Mode of presentation in the postoperative (late presentation) group

Presentation	(%)
Obstructive jaundice	43
Cholangitis	9.4
Persistent bile coming from the drain	28.6
Intra-abdominal bile collection	14.3
Jaundice and intra-abdominal bile collection	4.7

Table 3: Bile duct injuries detected postoperatively

Injuries	Number (%)	Management
Total	42/48 (87.5)	
Strasberg type A	18/42 (43)	Endoscopic stenting
Without retained stones	12/18 (66.6)	Endoscopic stenting
Requiring surgery	1/18 (5.6)	Endoscopic stenting followed by surgical ligation
With retained stones	6 (33.3)	Endoscopic stenting with sphincterotomy and stone extraction
Total	24/42 (57)	Roux-en-Y H-J
Strasberg type E1	1/24 (4.2)	
Strasberg type E2	8/24 (33.3)	
Strasberg type E3	5/24 (20.8)	
Strasberg type E4	2/24 (8.3)	
Strasberg type E5	8/24 (33.3)	
Total	28/48 (58.3)	
Postoperative anastomotic strictures	3/28 (10.6% of the jejunostomy group)	Balloon dilatation

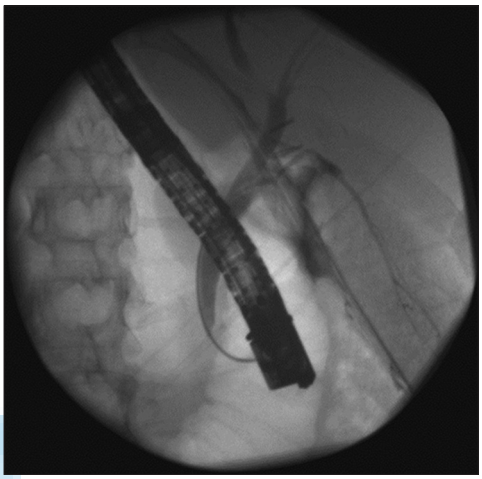

Figure 1: Strasberg type C bile duct injury indicating a leak from the right posterior branch

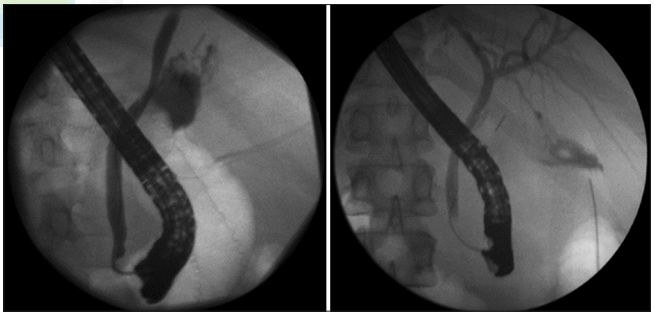

Figure 2: Strasberg type A bile duct injuries indicating a leak from (a) the cystic duct; (b) from the gallbladder bed; this patient ultimately required surgery

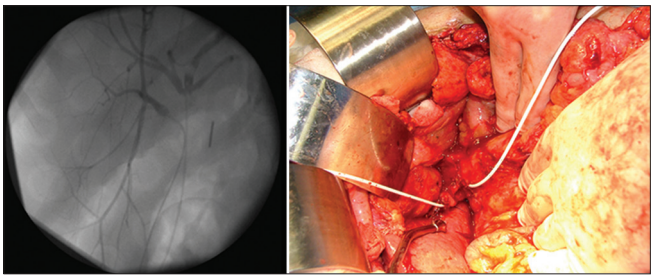

Figure 3: Strasberg type E4 bile duct injury. (a) IOC performed to map the liver. (b) Intraoperative image showing the distance between the right and left ducts

Discussion

Bile duct injuries typically develop due to a number of predisposing factors during cholecystectomy, including acute cholecystitis, anatomical bile duct variations, intraoperative bleeding from the cystic or hepatic arteries, and finally, failure to identify the structures of the triangle of Calot. These factors usually result in injuries that are secondary to surgeon's misperception rather than shortcomings in surgical skill, knowledge, or judgment.[2,4] The simple and basic rule of biliary surgery whereby no structure is ligated or divided until it is clearly identified can prevent and minimize the majority of bile duct injuries noted with LC.[3,5,6] Approximately 30% of all bile duct injuries are detected intraoperatively; when these injuries are detected, the surgeon should attempt to define the level of the injury before it worsens, with the aid of IOC, if indicated.[3] In the present study, only six cases were identified intraoperatively (12.5%), which was much lower compared to other studies. This decreased incidence may be due to the fact that the majority of patients were referred from other hospitals. Bile duct injuries following LC are more complex than those associated with the open procedure. Those following LC are typically more proximal; frequently associated with vascular injury, due to a thermal mechanism; and coexist with a biliary fistula.[2] Once the injury is clearly defined, immediate repair can be performed if the surgeon is sufficiently experienced, thus resulting in a significant decrease in morbidity, mortality, duration of hospitalization, and healthcare expenditure.[15] However, the lack of adequate resources and facilities, including sufficient surgical experience, to appropriately manage such injuries necessitates consultation with an expert hepatobiliary surgeon after appropriate drainage.[3] In the present study, we followed these guidelines, and all six cases of intraoperative bile duct injuries were managed immediately after performing IOC, including two cases of Strasberg type C injuries. Primary repair was performed with internal stenting**.** The other four cases (66.6%) included one type E2 (16.7%), two type E3 (33.3%), and one type E4 (16.7%) injuries; all these patients underwent Roux-en-Y H-J.

In order to detect a bile duct injury, the surgeon should have high index of suspicion. Patients who have an atypical course following cholecystectomy should be assumed to have a bile duct injury and be examined accordingly.[2] Approximately 70% of biliary injuries associated with LC are diagnosed late, and patients present with non-specific symptoms, such as vague abdominal pain, vomiting, and unexplained fever; however, in other cases, sepsis may develop due to severe biliary peritonitis or intra-abdominal abscess, as well as in cases where there is ligation, early stricture formation, jaundice, and/or cholangitis.[12] In the present study, 42 (87.5%) cases of bile duct injuries were identified postoperatively, with variable clinical presentations. Therefore, a high index of suspicion is required to avoid unnecessary delays in treatment and minimize morbidity and mortality.

Early referral to a tertiary care hospital can ensure a multidisciplinary treatment approach for the bile duct injury. Any sepsis or hemodynamic compromise should be treated with aggressive volume resuscitation, prompt drainage of bile fluid collection, and initiation of broad-spectrum antibiotics prior to any diagnostic intervention or operative repair.[12,13] The initial evaluation of a biliary injury depends on imaging, such as ultrasonography and CT, which can detect the presence of fluid collection or ascites in the peritoneal cavity that is indicative of a bile leak. Percutaneous drainage can confirm the presence of bile in the collection as well as facilitate appropriate drainage.[15] As the standard of care for confirming a biliary injury, ERCP also facilitates the definitive management of several injuries with temporary internal stents. In the present study, 18 (43%) patients underwent USGA and 6 (33.3%) patients required internal stenting with endoscopic removal of the retained stones, which is consistent with the findings of Pinkas *et al*. and other studies.[2,3,15,17] Although magnetic resonance cholangiopancreatography (MRCP) has been advocated for the diagnosis of the type of injury because of its non-invasive nature and ease of use, in our experience, we found that MRCP was of limited value in all major injuries due to bile leakage that resulted in several artifacts. Moreover, in cases where there was no major bile leakage, the injury was found to be mild and an ERCP was always indicated to facilitate the sphincterotomy and stent insertion, thereby decreasing the overall treatment cost that increases when MRCP is used and does not provide any additional valuable information. In contrast, some authors advocate the use of percutaneous transhepatic cholangiography (PTC) if there is complete disruption or occlusion of the proximal bile duct. PTC can help define biliary anatomy and decompress the biliary system.[18] In the present study, only one case had undergone PTC. However, we believe that IOC offers superior mapping of the entire liver, particularly in cases of serious bile duct injuries, when this procedure is mandatory to identify all segmental liver ducts, thus decreasing the utility of MRCP and PTC in such cases. In all cases, the entire liver, including its segments, has to be carefully delineated to avoid overlooking any small ducts during the repair, which can result in additional leakage postoperatively; however, this cannot be ensured when using MRCP or PTC.

In the late presentation group, our initial evaluation depended predominantly on ultrasonography and CT, and 18 (43%) cases with type A injury and 24 (57%) cases with type E1-5 injuries required further ERCP, indicating that most of these injuries were complex. Our findings are consistent with other studies.[3,19,20] The role of MRCP and CT to classify bile duct injuries remains controversial, with some authors considering MRCP and CT as potential delays in treatment.[3,21] A simple leak from the stump of the cystic duct discovered during LC can be corrected by placing an additional clip or a ligature loop, and most cases do not require a conversion to laparotomy.[22] Cases of Strasberg type A injury that were confirmed radiologically can be treated by ERCP and sphincterotomy or endoscopic stenting.[23] It has been suggested that an additional ERCP should be performed 6 weeks after stenting, and the stent should be removed if no further leakage or stricture is noted; in 88-94% of such cases, a favorable outcome is achieved.[23,24] In the present study, only 1 (5.6%) patient was not successfully treated by stenting and required surgery to suture a persistent bile leak from the gallbladder bed.

Most surgeons tend to repair injuries during the initial hospitalization in cases where abdominal sepsis has resolved. Other surgeons advocate waiting for up to 6 weeks before repair to allow for quiescence of the inflammation. However, dense adhesions may develop, thus making the repair more difficult.[24] In our center, we prefer prompt surgical management, and all patients were taken to the operating room within the same week of hospital admission, after completing the preliminary workup. An important factor associated with the new method (lowering of the hilar plate) is that the repair will yield viable and healthy tissue, thus making it feasible to perform, and lead to a better blood supply. Consequently, this will result in better outcomes and less strictures. As observed in the present study, the stricture rate decreased from 25% in the first group to 5% in the second group. Thus, the need for delaying the surgery to achieve a better result is inconsequential. However, if the new technique is not adopted, the surgery may need to be delayed, which results in an increased mental and physical burden for the patient.

Occlusion or transection of an aberrant right hepatic duct, or Strasberg type B and C injuries, requires reconstruction of the isolated segment with Roux-en-Y H-J.[1,3,24] Partial lateral ductal injuries, or Strasberg type D injuries, can be repaired primarily over an internal stent, provided that there is no significant ischemia or cautery damage at the site of injury. Complete Strasberg type D and E injuries require H-J with Roux loop.[22,23] Cases of Strasberg type E4 injuries, where proximal injuries are noted in multiple bile ducts, require separate anastomoses.[1,3] In the present study, Roux-en-Y H-J was performed in 24 (57%) patients who presented with bile duct injuries postoperatively. Most strictures develop after the bile duct injury, and those noted following biliary enteric anastomoses can be effectively managed with transhepatic dilatation and stent placement, although some eventually require surgical revision.[24] In total, 28 (58.3%) patients underwent H-J in the present study, of whom 3 patients (10.7% of the jejunostomy group) developed subsequent anastomotic strictures and were treated with percutaneous transhepatic balloon dilatation. These results are similar to other studies.[22,23] However, we noted a significant decrease in the rate of stricture formation when using the side-to-side technique compared to that noted in another study.[16] This requires greater surgical expertise and longer operating times, but results in a reduced number of strictures with a wider anastomosis and better vascular supply.

The small number of patients, the short follow-up period, and the single-center experience make this study somewhat limited. However, the main limitation is the technical difficulty in lowering the hilar plate. This technique is technically demanding and is not performed by many surgeons, making it available only in a small number of referral centers.

Conclusion

In cases presenting postoperatively, a multidisciplinary approach is required for diagnosis and appropriate management. Endoscopic management can be successful in type A injuries, whereas advanced cases typically require surgical intervention. If performed under optimal conditions by an experienced surgeon, H-J yields the best results.

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