Gastroenterology & Hepatology Letters

MINI-REVIEW

Diagnosis, Treatment, and Prevention of Iatrogenic Injury in the Lower Part of Common Bile Duct

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Abstract: Iatrogenic bile duct injury is one of the important problems in abdominal surgery and its incidence has shown an upward trend in recent years. Iatrogenic bile duct injury threatens the quality of life and life safety of patients. At present, there is a lack of diagnostic and treatment norms that have a guiding significance based on large-scale evidence-based medicine research. The injury to the lower part of the common bile duct, especially the joint of the biliary and pancreatic intestines, generally is more serious. This article introduces the current status, classification, common causes, diagnosis, treatment, and prevention regarding the iatrogenic injury in the lower common bile duct. A deeper understanding of this injury may help minimize the incidence of injury, standardize diagnosis and treatment and improve the prognosis of patients.

Keywords: Iatrogenic injury, Lower part of common bile duct, Diagnosis, Treatment, Prevention

Received: October 22, 2019
Accepted: December 6, 2019
Published Online: December 19, 2019

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CITATION
Bai L, Jin C, Wang S, 2019, Diagnosis, Treatment and Prevention of Iatrogenic Injury in the Lower Part of Common Bile Duct. *Gastroenterol Hepatol Lett*, 1(1):6-10.
DOI: 10.18063/ghl.v1i1.237

1 Introduction

Bile duct injury is a serious issue in hepatobiliary surgery. Iatrogenic bile duct injury is a serious problem faced by hepatobiliary surgeons. This form of injury is caused by iatrogenic factors such as surgery or other invasive diagnosis and treatment operations. The injury site may occur in any plane of the biliary tree[1]. Improper treatment lead to multiple, unnecessary surgeries, and great pain that the patients have to endure, and some cases may even result in severe infection, biliary cirrhosis, and even death[2]. Every hepatobiliary surgeon should take strict prevention of bile duct injury and be familiar with the principles of treatment to maximize the patient's benefit. Due to the special and complicated anatomy of the biliary-pancreatic-intestinal junction, it is difficult to diagnose and treat lower common bile duct injury which usually has a poor prognosis[3,4]. Nevertheless, we should pay more attention to improve the treatment and prevention of iatrogenic bile duct injury.

2 Classification of iatrogenic bile duct injury

Most of the iatrogenic bile duct injury is related to cholecystectomy, followed by biliary exploration, hepatectomy, and endoscopic sphincterotomy (EST), as well as gastrectomy, hepatic artery embolization, percutaneous transhepatic biliary drainage, endoscopic retrograde cholangiography, endoscopic biliary drainage, physical, or chemical ablation of hepatobiliary lesions[5,6]. The location of bile duct injury is directly related to the surgical procedures and can occur in different planes of the biliary tree. According to the degree of injury, it can be divided into partial injury, transverse injury, bile duct loss, fibrosis, and stenosis.

The commonly used classification system of bile duct injuries mainly includes Bismuth classification, Strasberg classification, Neuhaus classification, Csendes classification, and Stewart-Way classification, but these classifications are not ideal[7,8]. In China, the simplified classification method based on the plane and extent of damage, as proposed by Academician Zhiqiang Huang, is very useful. Based on this classification method[9], iatrogenic bile duct injury can be classified in accordance with the following criteria:

Biliary plane

(1) Intrahepatic bile duct system (generally a Grade 2 hepatic duct branch and above plane).
(2) Bile duct in the peri-hepatic portal area (generally including the Grade 1 liver tube above the confluence of the cystic duct and the common hepatic duct).
(3) Extrahepatic bile duct or common bile duct (generally referred to as common bile duct, ampullary injury at the lower end of the common bile duct is a special site injury).

Degree of injury

(1) Partial injury
(2) Transverse injury
(3) Transverse injury with partial biliary tissue loss (according to the characteristics of surgical treatment, it is further divided into complete hepatic duct junction and missing hepatic duct junction).
(4) Stenosis (such as suture, improper use of titanium clips, and the result of ischemia or inflammation, no significant history of damage).

Based on the anatomical location, injury factors, lesion characteristics, and prevention strategies of biliary tree injury, the bile duct injury can be subdivided into intrahepatic bile duct injury, extrahepatic bile duct injury, and pancreaticoduodenal bile duct injury, which caused widespread concern and discussion[10].

3 Types of the lesions in the lower common bile duct and causes

The lower part of the common bile duct injury includes the distal end of the common bile duct and the joint of the biliary and pancreatic intestine. The nature of the injury factors is mainly mechanical and ischemic[11]. Injury of the biliary and pancreatic junction is not common, but it is of great significance because of the serious consequences if mistreatment is given. The injury can be resulted from the conditions described in the following[12]:

(1) When the common bile duct is probed, the metal probes and stone pliers are used excessively at the distal end, resulting in penetrating injury to the lower part of the common bile duct.
(2) EST incision is too long and deep, exceeding the inner segment of the duodenal wall of the common bile duct.
(3) Ischemic stenosis of the biliary ampulla of the common bile duct is resulted if the blood vessel is cutoff during gastrectomy since the blood supply at the end of the common bile duct is mainly from the posterior pancreaticoduodenal artery divided by the gastroduodenal artery.
(4) Long-term compression of biliary stone at the end of the common bile duct causes ischemic necrosis and perforation of the bile duct wall. The lesion was exposed after the stone was removed.

4 Diagnosis

The structure of the lower part of the common bile duct that is hidden in the duodenum and the back of the pancreas is complex. The damage often occurs in the weak right-lateral bending of the wall, often involving the pancreas, and/or the duodenum. No bile leakage should happen during surgery. T-tube will be placed in the common bile duct, then pressurized water is injected to T-tube, and only retroperitoneal edema is visible. Therefore, the rate of missed diagnosis during surgery is high, which affects the prognosis[13,14]. Because the leakage liquid contains pancreatic juice and duodenal contents in addition to bile, pancreatic enzyme in pancreatic juice is strongly activated by bile, resulting in pores of larger sizes, more serious inflammation, and very obvious symptoms. These pathological changes are not found in other parts of the bile duct. In a brief period of time, the symptoms of the patients are not considered representative, and secondary infections will occur after some time. The fever and abdominal pain will worsen. The diagnosis is often late.

Hepatobiliary surgeons must be aware that any surgeries to the right-upper quadrant part of the abdomen can possibly cause bile duct injury. Care should be taken during operation to confirm the integrity of the bile duct structure and to observe any accidental injury. Bile duct injury must be diagnosed and treated in time and strive for intraoperative diagnosis. Delayed diagnosis can cause serious complications[15].

The following procedures must be considered while performing surgery on the patient with the injury of the lower part of the common bile duct[16]:

(1) A metal probe is used to blindly explore the distal part of the common bile duct, and then it will pass through the intestinal wall.
(2) The probe emerges out, reaching the region of duodenum or retroperitoneum.
(3) After bile duct exploration, retroperitoneal edema or exudate is visible when water is injected through T-tube, and the operation field or retroperitoneum will be stained blue after injection of methylene blue solution.
(4) Extravasation of contrast medium is seen in the intraoperative cholangiography.

(5) Intraoperative choledochoscopy will reveal the site of damage.

The following cases should be considered after the operation of the lower common bile duct[17]:

(1) Post-operative fever, right lower back pain, progressive exacerbations, but peritoneal irritation.
(2) Imaging findings of exudate and gas in peripancreatic and retroperitoneal space.
(3) Ultrasound or CT-guided diagnostic abdominal puncture or catheter drainage in peritoneal effusion, bile-like fluid is found.
(4) Through the T-tube cholangiography, the contrast agent extravasation or leakage is found.

5 Treatment

The purpose of the treatment of bile duct injury is to restore or reconstruct the structure and function of the bile duct. The treatment should be given as early as possible. The treatment should be given by taking into consideration of the location, extent, time interval of the injury, the local and systemic inflammatory response. The principle of surgical injury control should also be considered.

After intraoperative diagnosis of the lower common bile duct injury, the Kocher incision was made to expose the duodenum, and then the duodenum is turned inward to reveal posterior duodenum, pancreatic head, and common bile duct, in an attempt to identify the site of injury so that treatment can be given immediately. The T-tube drainage of the common bile duct is performed and the abdominal drainage is placed behind the duodenum. At the same time, duodenal perforation should be treated immediately after the damage, and the stomach tube is put into the duodenum for decompression[18,19]. In patients with pancreatic injury, the retroperitoneal incision is required to expose pancreatic head and duodenum, and the peripancreatic drainage should be placed. When the above-mentioned examination still cannot find a clear piercing point, the Oddi Sphincter angioplasty is feasible, and the piercing point of the common bile duct in the ampulla is sutured under the direct view. For complicated cases of simultaneous injury to the pancreas and duodenum, to achieve bile and pancreatic shunt and avoid serious complications, the common bile duct can be transected, the distal end is closed, and the proximal end and the jejunum are Roux-en-Y[20].

Endoscopic surgery resulting in lower common bile duct injury should be stopped immediately. Patients with mild symptoms can be treated with traditional treatments, such as fasting, gastrointestinal decompression, managing infection, acid suppression, enzyme inhibition, nutritional support, and abdominal puncture drainage[21]. If the condition worsens during this period, it is necessary to perform surgery on time.

Missed intraoperative diagnosis and delayed postoperative diagnosis of the lower common bile duct injury often lead to poor patient conditions, systemic infection symptoms and poor surgical tolerance. For this complex type of bile duct injury with severe comorbidities, it is advisable to adopt a staged treatment strategy. Simple and effective methods are needed to control local and secondary pathological damage and restore the patient's systemic physiological homeostasis for further safety. Injury-controlled surgery should be emphasized to achieve the purpose of controlling digestive tract leakage and local and systemic infection with minimal trauma, and prepare for the second-stage repair and reconstruction surgery[22]. Specific means include abscess debridement, unobstructed abdominal and retroperitoneal gap drainage and continuous irrigation, bile and pancreatic shunt, duodenal diverticulosis, and jejunostomy. The bile and pancreatic shunt prevents the pancreatic enzyme from being activated, digesting and corroding the tissue around the laceration, and spreading the infection. Duodenal diverticulum can prevent food from passing through the device, and change the humoral regulation to reduce the secretion of biliary and pancreas, thereby reducing the amount of leakage and promoting the healing of the biliary and pancreatic fistula. Jejunostomy can facilitate enteral nutrition, which is conducive to the recovery of digestive tract function and improve systemic nutritional status. After the lower part of the common bile duct was treated with initial surgery, the bile leakage, pancreatic leakage, intestinal leakage, and infection will be controlled, the scope of injury becomes clear and the local inflammatory reaction subsides. The second-stage surgery was feasible for proximal common bile duct-jejunum Roux-en-Y anastomosis and stomach-jejunum anastomosis to restore biliary and gastrointestinal continuity[23,24].

For the ischemic stenosis of the lower common bile duct caused by gastrectomy, bile duct-jejunum Roux-en-Y anastomosis or Oddi Sphincter angioplasty will be useful.

6 Prevention

Adequate technical training and good surgical judgment are the key to reducing surgical complications. Strict specialist training system and surgical access system are the fundamentals of surgical safety. The hepatobiliary surgeon should be familiar with the anatomical relationship and variation of the extrahepatic bile duct, as well as the particularity of the anatomical structure of the biliary-pancreatic-intestinal junction. Fully understand the harmfulness of iatrogenic bile duct injury, and treat each operation with a high degree of responsibility. With the occurrence of pathological changes, such as local edema, congestion, displacement, and tissue weakness in the lower part of the common bile duct after the lesion, it is risky to perform blind exploration of the distal bile duct using the metal device, and all surgeries must be conducted meticulously.

To avoid penetrating injury by improper force, the use of metal instruments in non-direct view to explore the distal common bile duct is not suitable. The surgeon

can slide the instrument along the physiological curvature of bile duct and slowly advance. If necessary, Kocher incision can be made to expose duodenum and pancreas. In the case of probe resistance, it should be treated with choledochoscopy under direct vision. It is forbidden to use metal instruments to advance violently to the distal part of the bile duct. After the biliary exploration, the T-tube water injection test is routinely used after suturing the bile duct to check for the leakage in the retroperitoneal space and the duodenal ligament. If the distal bile duct injury is suspected, the pancreatic and duodenal segments of the bile duct should be examined by revealing the dorsal surface of the pancreatic and duodenum through Kocher incision. Intraoperative choledochoscopy and cholangiography are helpful in the diagnosis and localization of distal bile duct injury. The key point of the prevention of EST in the lower part of the bile duct is to choose the correct orientation when cutting and to control the length and depth of the incision. The strength of the net and the balloon expansion should be appropriate. The main focus of the prevention of bile duct injury during gastrectomy is to carefully expose the duodenum and to protect the posterior duodenal artery[25,26].

7 Conclusion

Serious complications can occur in the injured lower segment of the common bile duct. If detected and treated during the operation, the degree of injury can be minimized. Once the injury diagnosis is established, a planned, step-by-step standardized treatment should be in place to treat the patient. With the development of surgical techniques and equipment, and the advancements of the treatment concepts, the understanding, and treatment of the iatrogenic injury of the lower common bile duct have been greatly improved. Similarly, short-term and long-term prognoses are also significantly improved.

Acknowledgments

This work was supported by National Nature Science Foundations of China (No. 81000987), China Postdoctoral Science Foundation Funded Project (No. 201003744), Xi'an Science and Technology Project (No. 201805094YX2SF28 (3)), and Xi'an Health Commission Project (No. J201903071).

Conflicts of interest

The authors declare that they have no conflicts of interest.

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