

Diagnosis and Treatment of Iatrogenic Bile Duct Injuries

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ÖZET

İyatrojenik safra yolu yaralanmasında tanı ve tedavi

Amaç: İyatrojenik safra yolu yaralanmaları hepatopankreatikobiliyer, gastroduodenal ve safra kesesi ameliyatları gibi üst gastrointestinal sistem cerrahileri sırasında gelişebilen bir komplikasyondur. Bu çalışmada amacımız, bu tip cerrahi müdahaleler sırasında gelişen safra yolu yaralanmaları olan hastalarımızda uyguladığımız tanı ve tedavi yöntemlerini değerlendirmektir.

Materyal ve Method: Ocak 2005 ve Ocak 2012 tarihleri arasında Bakırköy Dr. Sadi Konuk Eğitim ve Araştırma Hastanesi Genel Cerrahi Kliniği'nde iyatrojenik safra yolu yaralanması nedeniyle tedavi edilen hastalar; demografik verileri, yaralanma nedeni, tanı konulma zamanı, klinik ve laboratuvar değerleri, Strasberg sınıflamasına göre safra yolu yaralanma tipleri, tanı araçları, tedavi yöntemleri, hastanede yatış süreleri, mortalite ve morbidite oranları açısından geriye dönük olarak değerlendirildi.

Bulgular: İyatrojenik safra yolu yaralanması olan toplam 42 hastanın 21'i kadın ve yaş ortalaması 52.9 (24-81 yaş) idi. Bu yaralanmaların 38'i (%90.4) kolesistektomi ameliyatı sırasında meydana gelmişti. Bu 42 hastanın 25'inde Strasberg Tip A sınıfı yaralanma tespit edildi (%59.9). Hastaların 35'inde yaralanma ameliyat sonrası dönemde tespit edilebildi. Tanıda transabdominal ultrason ilk basamak tanı aracı olarak kullanıldı ancak kesin tanı aracı genel cerrahi ekibi tarafından yapılan endoskopik retrograd kolanjiyopankreatikografi idi. Hastaların 10'u klasik cerrahi yöntemler ile tedavi edildi (%23.8). Cerrahi dışı minimal invazif yöntemler için uygun durumdaki 32 hasta ise endoskopik retrograd kolanjiyopankreatikografi ve perkütanöz transhepatik kolanjiyografi ile tedavi edildi (%76.2).

Sonuç: İyatrojenik safra yolu yaralanmaları genellikle bir üst gastrointestinal sistem cerrahisi sırasında gelişebilen ve tanısının konulması ameliyat sonrası geç dönemlere kadar uzayabilen bir cerrahi komplikasyondur. Bu durum klasik cerrahi yöntemler ile tedavi edilebileceği gibi günümüzde uygun vakalarda endoskopik ve perkütanöz cerrahi dışı yöntemlerle de tedavi edilebilmektedir.

Anahtar kelimeler: İyatrojenik safra yolu yaralanması, endoskopik retrograd kolanjiyopankreatikografi, perkütanöz transhepatik kolanjiyografi

ABSTRACT

Diagnosis and treatment of iatrogenic bile duct injuries

Objective: Iatrogenic bile duct injuries may occur during the hepatopancreaticobiliary surgery, gastroduodenal surgery and cholecystectomy. We aimed to evaluate the diagnosis and the treatment of our patients who developed bile duct injuries through such surgical interventions.

Materials And Methods: The patients treated for iatrogenic bile duct injury in Bakırköy Dr. Sadi Konuk Training and Research Hospital General Surgery Clinics between January 2005 and January 2012 were retrospectively evaluated in terms of demographics, the causes of the injury, time of diagnosis, clinical and laboratory findings, types of bile duct injuries according to Strasberg classification, diagnostic tools, treatment methods, length of hospital stay, morbidity and mortality rates.

Results: Of 42 cases, 21 were female, with a mean age of 52.9 (24-81). Thirty eight of these injuries occurred due to cholecystectomy (90.4%). Twenty five of these 42 cases were Strasberg Type A injuries (59.5%). In 35 patients iatrogenic bile duct injury was detected after the surgery. Abdominal ultrasonography was used as the first-line diagnostic tool and endoscopic retrograde cholangiopancreatography which was performed by the surgical team was used as a method for definitive diagnosis. Of the subjects who were diagnosed with this injury, 10 were surgically treated (23.8%). The remaining 32 suitable patients for non-surgical methods were treated by endoscopic retrograde cholangiopancreatography and percutaneous transhepatic cholangiography (76.2%).

Conclusion: Iatrogenic bile duct injury is a surgical complication that may usually develop after the upper gastrointestinal surgery and that may be diagnosed in the later stage of the post-operative period. This condition can be treated non-surgically in appropriate cases with endoscopic and percutaneous transhepatic methods as well as surgical interventions.

Key words: Iatrogenic bile duct injury, endoscopic retrograde cholangiopancreatography, percutaneous transhepatic cholangiography

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INTRODUCTION

Iatrogenic bile duct injuries (IBDI), which were first described by Sprengel in 1891, may occur during several abdominal interventions, such as hepatobiliary, pancreatic, gastric and duodenal surgeries. Today, its incidence is highest during the cholecystectomy (0.1-0.2%) and especially after the laparoscopic cholecystectomy (0.4-0.6%) (1). About 77-89% of the injuries are noticed during the post-operative period. Iatrogenic bile duct injury may result in abdominal pain, bile leakage, jaundice and cholangitis during the post-operative period.

Treatment modality to be chosen may be surgical, endoscopical and/or radiological therapy according to the localization and the severity of the injury. In this study, we aimed to evaluate the diagnosis and the treatment of our patients who have biliary tract injuries following several surgical interventions (2,3).

Bile duct injuries may be classified by the mechanism of injuries, type of injuries, the localization of the injuries, whether there is the continuity of bile secretion and the time of diagnosis. Each of these factors plays a role in the determination of the appropriate repair approach. Among these, Bismuth classification is used in the classical surgery and defines intact proximal bile duct mucosa for stenosis and anastomosis. Mc Mahon classification categorizes the bile duct injuries into three groups, as bile duct laceration, ductal transection/excision and bile duct stenosis (4). Strasberg classification renders Bismuth classification more comprehensive by incorporating other laparoscopic types of bile duct injuries (5).

For the diagnosis of bile duct injuries, many imaging methods are used. If injury is suspected during the surgery, cholangiography would be one of the most useful imaging methods to determine the localization and the extent of the injury. When bile duct injury is suspected post-operatively, the imaging method of choice should be ultrasonography (US). Here, it is aimed to detect extended bile ducts, to evaluate intra-abdominal fluid collection and, if available, to confirm the presence of the bile using US assisted percutaneous puncture and aspiration and, if required, to implant an intra-abdominal catheter for the drainage.

Contrasted computerized tomography (CT) is superior to ultrasonography in the detection of intra-abdominal abscess and potential vascular injuries. Angiography may

be used for the diagnosis and the treatment of vascular injuries that accompany bile duct injuries. Hepatobiliary scintigraphy may detect the bile leakage, but is inadequate to determine the anatomic localization of the leakage (2). Other modalities that may be used to evaluate the bile ducts include magnetic resonance cholangiopancreatography (MRCP), endoscopic retrograde cholangiopancreatography (ERCP) and percutaneous transhepatic cholangiography (PTC). Although MRCP is a non-invasive diagnostic tool that clearly describes the anatomy of the bile ducts, it may not show the minor biliary leakages.

In the treatment of bile duct injuries, the appropriate therapy is chosen according to the time of diagnosis, type of injury, extent of the injury and the localization of the injury. If bile duct injury is noticed during the primary surgery, cholangiography should be used to define the anatomy of the bile duct and additional dissections should be avoided to prevent the devascularization of the bile duct. If the injury is confirmed but there is no adequate experience for complex biliary reconstruction, a drain should be placed into the operational site and the patient should be referred to an experienced hepatobiliary surgery unit. As the performance of primary repair or bilioenteric reconstruction for the treatment of bile duct injuries diagnosed during the primary surgery is a difficult procedure in the presence of non-dilated bile ducts, this decision should be made based on the experience of the related surgeon in this field (6).

MATERIALS AND METHODS

The patients treated with the diagnosis of IBDI in the General Surgery Clinic of Bakırköy Dr. Sadi Konuk Training and Research Hospital between January 2005 and January 2012 were evaluated retrospectively. Data collection from patients' records were including: demographics (age, gender), causes of the injury, time of diagnosis, clinical (presence of jaundice, cholangitis e.g.) and laboratory findings [complete blood count, direct and indirect bilirubin, aspartat aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase (ALP), gamma glutamyl transferase (GGT)], types of bile duct injuries according to Strasberg classification, the diagnostic tools (US, CT, ERCP, MRCP or PTC) that were used, the treatments modalities that were chosen, duration of hospital stay and morbidity and mortality rates.

RESULTS

Of the 42 patients with iatrogenic bile duct injury, 21 were female, with a mean age of 52.9 (24-81). Thirty eight of these injuries occurred during the cholecystectomy surgery (90.4%). Of the remaining cases, two developed during the subtotal gastrectomy and D2 lymph node dissection, one during puncture, aspiration, injection, and reaspiration (PAIR) intervention for hepatic hydatid cyst and one during the ulcer perforation surgery. Of the bile duct injuries occurred during the cholecystectomy, 35 developed during laparoscopic surgery and 3 during open surgery (Table 1).

Thirty six of the patients who had IBDI during the cholecystectomy, had been operated in our clinic and 2 had been referred to our clinic with suspected IBDI after laparoscopic cholecystectomy performed in other medical centers. In our clinic, a total of 6,400 cholecystectomy operations were performed during the same period of this study; incidence rate of IBDI was calculated to be 0.6%.

Only 7 of all bile duct injuries that occurred in our clinic could be noticed during the operation. In other patients, the injury was noticed 15.9 days (1-150) after the surgery. In these 35 patients who were detected to have IBDI during the post-operative period, most common clinical findings observed included abdominal pain and distension (n=18) and jaundice (n=9) respectively. In eight patients, it was observed that the bile leaked from the intra-abdominal drains. Mean laboratory values of the

patients with a diagnosis of IBDI were as follows: white blood cell count $10.1 \times 10^3 / \mu\text{L}$ (5.9-16), total bilirubin 2.99 mg/dL (0.4-24), conjugated bilirubin 1.97 mg/dL (0.2-17), aspartate aminotransferase 44.7 IU/L (13-170), alanine aminotransferase 58.5 IU/L (13-313), gamma-glutamyl transferase (GGT) 127.1 IU/L (14-685), alkaline phosphatase (ALP) 154.9 IU/L (12-1,617).

The types of injuries of these 42 cases of IBDI, based on Strasberg classification were; Strasberg A in 25 patients, Strasberg D in 7 patients, Strasberg B in 4 patients, Strasberg E1 in 4 patients and Strasberg E2 in 2 patients. In 35 patients in whom IBDI was detected after the surgery, abdominal US was used as the first-line diagnostic tool and ERCP was used as definitive diagnostic method.

Ten of these patients diagnosed with IBDI were surgically treated (23.8%). Most commonly administered surgical method was roux-en-y hepatico-jejunostomy for 8 patients. While two patients underwent the repair of primary main bile duct, two patients had roux-en-y choledoco-jejunostomy and one patient underwent the re-ligation of pre-opened cystic rudiment (Table 2). Other 32 patients (76.2%) diagnosed with IBDI were treated using non-surgical methods, such as ERCP and PTC (Table 3). Most of these patients in non-surgical group had Strasberg A type bile duct injuries. Besides sphincterotomy or ERCP plus sphincterotomy temporary plastic biliary stents were implanted to 29 of these patients, whereas 3 patients had concomitantly sphincterotomy and percutaneous transhepatic drainage. Stents of the

Table 1: Surgical interventions that lead to iatrogenic bile duct injuries and how the injuries are noticed

Surgical interventions that lead to IBDI	Noticed during the primary surgery	Noticed during the post-operative period	Total (%)
Open cholecystectomy	2	1	3 (7.1)
Laparoscopic cholecystectomy	3 (2 referred from another center)	32	35 (83.3)
Subtotal gastrectomy + D2 dissection	2	-	2 (4.8)
Peptic ulcer perforation	1	-	1 (2.4)
Hepatic cyst hydatid (PAIR procedure)	1	-	1 (2.4)
Total (%)	9 (21.4%)	33 (78.6%)	42 (100%)

Table 2: Reconstruction methods of choice for iatrogenic bile duct injuries treated by surgical repair

Bile duct reconstruction type	Repair during the primary surgery	Repair during the second session	Type of injury
Roux-en-y hepatico-jejunostomy	4	2 (subjects referred from another center)	Strasberg B,E1,E2
Roux-en-y choledoco-jejunostomy	1	-	Strasberg E2
Primary repair over T tube	2	-	Strasberg D
Re-closure of the cystic rudiment	-	1	Strasberg A
Total	7	3	10

Table 3: The interventions performed for iatrogenic bile duct injuries treated by non-surgical methods

Non-surgical methods	Type of injury	Number of patients
Sphincterotomiy ± Temporary stent	Strasberg A, B, D	29
Sphincterotomiy + PTC drainage	Strasberg A	3
Total		32

patients in whom temporary biliary stent was implanted were removed at 6th week with ERCP.

Improvement was defined as the regression of the clinical findings, improved laboratory values and in those treated with surgical intervention, the cessation of the bile flow from intra-abdominal drain. Mean hospital stay was 21.1 days (2-78) for the patients treated with surgery and 12.2 days (1-67) for the patients treated using non-surgical methods.

Three of 10 patients who were treated with surgical intervention developed complications in the post-operative period (33.3%). One patient developed early biliary stenosis, one patient had anastomotic leakage following the hepatico-jejunostomy and one patient developed acute cholangitis. In the patient who showed anastomotic leakage after the hepaticojejunostomy, hepatic hemorrhage developed after percutaneous transhepatic drainage. Hemorrhage was treated using conservative methods. Of 32 patients who were treated using non-surgical methods, two died following the development of acute pulmonary embolism.

DISCUSSION

Based on the study performed by Linhares et al, iatrogenic bile duct injuries are commonly seen in the young women (7). This data may be supported by the higher incidence of gallbladder pathologies and, thereby, of surgical interventions in the women. In our study, which was conducted with a limited number of patients, the incidence of IBDI was equal in both genders at middle age.

IBDI is seen after the cholecystectomy performed to treat the benign diseases of the gall bladder at a rate of 71-95% (8). IBDI is more commonly observed after the laparoscopic cholecystectomy compared to open cholecystectomy (0.4-0.6% and 0.1-0.2% respectively) (1). In addition to cholecystectomy, it may also be observed after several intra-abdominal operations, such as hepatic, pancreatic and gastroduodenal surgeries.

In the development of IBDI, many factors that result

from anatomic variations occurring in the operational site, such as acute and chronic inflammations, play a role and among those surgical experience being the major causal factor (9). Consistent with the literature, in our series, 90.5% of the IBDI cases were observed during or after the cholecystectomy surgery. Of these, 95% were laparoscopic cholecystectomy.

Early diagnosis is vital in bile duct injuries. However, only 11-23% of IBDIs may be diagnosed at the time of injury (2). The injuries, which are noticed during the primary surgery, should be anatomically defined using perioperative cholangiography and an additional dissection should be avoided to prevent the devascularization of the bile ducts. In our series, only 7 cases could be diagnosed during the operation (16.6%).

Majority of the patients with IBDI initially show mild and moderate symptoms, such as vague abdominal sensitivity and pain, abdominal distension and nausea-vomiting (10). In our series, 83.3% of the cases were diagnosed during the post-operative period. Mean time to diagnosis was 15.9 (1-150) days following the operation. Major complaints and findings of these 35 patients diagnosed with IBDI after the operation included abdominal pain, distension, jaundice and bile leakage from the intra-abdominal drain. In bile duct injury patients, liver function tests and cholestatic enzymes may either be elevated supporting the clinical suspicions, or may remain within the normal ranges.

If there is a stenosis or a complete occlusion of the bile duct bilirubin values increase, whereas a slight elevation of values may be observed as a result of normal or peritoneal bile absorption in the presence of bile leakage (11). In our series, majority of the patients with clinical findings showed mild leukocytosis and elevated conjugated bilirubin as well as significantly elevated levels of cholestatic enzymes, such as GGT and ALP.

In Strasberg classification, bile duct injuries were classified from A to E. E was classified in itself from E1 to E5 using Bizmuth classification (Table 4). Moreover, other classifications that included other potential lesions, such as Bergman,

Table 4: Strasberg's classification, 1995 (21)

Type	Criteria
A	Cystic duct leaks or leaks from small ducts in the liver bed
B	Occlusion of a part of the biliary tree, almost invariably the aberrant right hepatic ducts
C	Transection without ligation of the aberrant right hepatic ducts
D	Lateral injuries to major bile ducts
E	Subdivided as per Bismuth's classification into E1 to E5
	E1 Low common hepatic duct (CHD) stricture, with a length of the common hepatic duct stump of >2 cm
	E2 Proximal CHD stricture-hepatic duct stump <2 cm
	E3 Hilar stricture, no residual CHD, but the hepatic ductal confluence is preserved
	E4 Hilar stricture, with involvement of confluence and loss of communication between right and left hepatic duct
	E5 Involvement of aberrant right sectorial hepatic duct alone or with concomitant stricture of the CHD

Neuhaus, Csendes ve Stewart, were also recommended (12). In our series, we used Strasberg classification. In our series, 25 patients had Strasberg A, 7 patients had Strasberg D, 4 patients had Strasberg B, 4 patients had Strasberg E1 and 2 patients had Strasberg E2 injuries.

ERCP does not only clearly reveal the localization and the anatomy of the bile ducts, but also allows to implant extra-hepatic biliary stents and to perform sphincterotomy for therapeutic purposes in the appropriate patients. PTC may provide transhepatic implantation of the biliary stent, especially by becoming prominent in complete biliary ligation or transection conditions, to evaluate the anatomy of the bile duct in the proximity of the injury. It may be used to control the bile leakage in case of obstruction or stenosis by leading to the decompression of proximal bile ducts and decreasing the biliary pressure.

Drainage by PTC may also be used to ensure the decompression of the bile ducts at an early stage, following the definitive treatment of the bile duct injuries. In addition, it allows to perform post-operative cholangiography imaging (13). In our series, all patient with suspected bile duct injury underwent abdominal US as the first-line imaging method. The patients who showed intra-abdominal free fluid and/or bile duct dilatation in US underwent ERCP.

If the surgeon is experienced in bile duct reconstruction, he/she can repair the injury within the same session (5). Many studies showed that the performance of the early repair of biliary injuries by hepatobiliary surgeons in the reference centers yielded better outcomes (14). In the bile duct reconstruction, Roux en-y hepatico-jejunostomy is the most preferred modality (15). McMahon et al. classified the bile duct injuries as major and minor, and

they recommended primary repair with or without T tube for minor injuries and hepatico-jejunostomy for major injuries (4). In our series, 4 of 7 patients in whom we detected bile duct injuries during the operation underwent roux-en-y hepatico-jejunostomy due to the presence of a common hepatic duct injury. Two patients with common bile duct injury had primary repair over T tube and one patient with an injury nearby the common bile duct had been treated by roux-en-y hepatico-jejunostomy. These bilioenteric reconstructions were performed in our clinic by the surgeons who had experience of hepatobiliary surgery.

Bile duct injuries were generally defined as Strasberg Class A, which is a minor bile duct injury (16). Most common reasons of the injury include the failure of the clips used to completely close the cystic duct, spontaneously falling of clips, late necrosis of the cystic duct by electrocauterization or expansion of the cystic duct due to the calculi present in the common hepatic duct (2).

While traditional treatment modality for bile leakage is surgical repair, more modern methods such as drainage and stent implantation endoscopically or percutaneously, are introduced as alternative modalities of the surgery for the treatment of minor bile duct injuries (17). In the bile leakage that develops without leading to large tissue loss in the main bile duct, the condition may be treated up to a rate of 70-90% using endoscopic sphincterotomy and stent. If the leakage stops, the stent implanted into the main bile duct can be removed approximately 6 weeks later in average (18).

In our series, 25 of 42 patients with bile duct injury had Strasberg Class A injury and, of these, 24 were treated using endoscopic and percutaneous drainage. Only in

one patient with Strasberg Class A injury, surgical therapy had to be performed. While 3 of 4 patients with Strasberg Class B injury were treated using sphincterotomy and stent, one patient with Strasberg Class B injury was treated using roux-en-y hepatico-jejunostomy following percutaneous transhepatic stent implantation. Five of 7 patients with Strasberg Class D injury were treated using sphincterotomy and stent. All of the stents implanted in the main bile duct were removed at 6th week after a control ERCP. Six patients with Strasberg Classes E1 and E2 injuries were treated by surgical repair.

If left untreated, bile duct injury may lead to intra- and extrahepatic bile duct stricture, biliary peritonitis, sepsis, multiple organ failure, biliary cirrhosis, hepatic failure and, ultimately, death (19-21). After the bile duct reconstruction operation, the complications, such as stenosis of hepatico-jejunostomy anastomosis, cholangitis, secondary biliary cirrhosis, portal hypertension, intra-hepatic calculus development and hepatic failure may develop. In our series, among 7 patients who underwent reconstruction, one developed early biliary stenosis, one developed anastomotic leakage and one developed cholangitis. It was reported that, after

the endoscopic sphincterotomy, the complications such as bleeding, pancreatitis, cholangitis, duodenal perforation and aspiration pneumonia, occur at a rate of approximately 10%. Systemic air embolism is a rare but potentially fatal complication (20). Two of our patients died due to pulmonary embolism developed after the sphincterotomy.

IBDI is a surgical complication that may develop after the upper abdominal surgery and that is usually diagnosed in the later stages of the post-operative period. It can be repaired by a surgeon who has experience in the bile duct surgery immediately after being noticed and, in the absence of this opportunity; the patient should be referred to a center experienced in this area. For the treatment of this condition, which can be fatal if not treated, less invasive therapeutic modalities such as endoscopic and percutaneous transhepatic interventions should be considered for appropriate cases as well besides the classical surgical methods.

Treatment approach should be selected by taking into account mainly the factors such as the size and the localization of the injury and the time of diagnosis, the medical condition of the patient and the experience of the surgeon.

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