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• BRIEF REPORTS •

A new method of preventing bile duct injury in laparoscopic cholecystectomy

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Abstract

AIM: Of all the complications of laparoscopic cholectecystomy, bile duct injury (BDI) is the most serious complication. The prevention of injury to the common bile duct (CBD) remains a significant concern in laparoscopic cholecystectomy (LC). Different kinds of methods have been advanced to avoid this injury but no single method has gained wide acceptance. Because of various limitations of current methodologies we began a study using cold light illumination of the extrahepatic biliary system (light cholangiography LCP) to better visualize this area and thereby reduce the risk of bile duct injury.

METHODS: Thirty-six patients with cholelithiasis were divided into two groups. Group I (16 cases) received LCP and group II (20 cases) received methelenum coeruleum cholangiography (MCCP). In group I cold light was used to illuminate the common bile duct by leading an optical fiber into the common duct with a duodenoscope at the time of LC. The light coming from the fiber in the CBD could clearly illuminate the location of CBD and hepatic duct establishing its location relative to the cystic duct. This method was compared with the dye injection technique using methelenum coeruleum.

RESULTS: In group I thirteen cases were successfully illuminated and three failed. The cause of three failed cases was due to the difficulty in inserting the fiber into the ampulla of Vater. No complications occurred in the thirteen successful cases. In each of these successful cases the location of the common and hepatic ducts was clearly seen differentiating the ductal system from surrounding anatomy. In ten cases both the left and right hepatic ducts could be seen and in three only the right hepatic ducts were seen. In four of the thirteen cases, cystic ducts were also seen. In group II, eighteen of the twenty cases were successful. The location of extrahepatic ducts became blue differentiating the ductal system from surrounding anatomy. Two cases failed due to a stone obstructing the cystic duct, and extravisation of the dye turned the entire area blue. LCP showed the common and hepatic ducts more clearly than MCCP.

CONCLUSION: LCP is the only technique that can clearly and directly show the location of the extrahepatic biliary system and may be useful in selecting cases of uncertain anatomy in the prevention of bile duct injury.

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INTRODUCTION

Bile duct injury continues to be one of the most serious complications of LC. The principal cause is the difficulty in recognition of the junction of the cystic duct to the hepatic duct. A number of methods have been advanced to avoid this error but no single method has gained wide acceptance. From March 2001 to October 2003 we used LCP for illumination of the biliary system in 36 cases and believe it is quite useful.

MATERIALS AND METHODS

Patients

Thirty-six patients with cholelithiasis, including 16 males and 20 females aged 41 to 66 years (mean age: 56 years) were selected for the procedure and divided into two groups. Group I (16 cases) received LCP and group II (20 cases) received MCCP.

Materials

Laparoscopic equipments were produced by Stryker and duodenoscopes with a channel diameter of 3.5 cm and 4.2 cm respectively were from Olympus. Optical fibers were specially produced according to our own design.

Methods

All patients drank 500 mL 100 g/L mannitol 15 h before operation and were fasted during this period. All cases received general anesthesia. In group I, Calot's triangle was dissected carefully and the relationship of the cystic duct to the hepatic and common bile ducts was noted. Duodenoscope was then introduced and the optic fiber was advanced into the common duct. When the light was turned on, the extra hepatic ducts were clearly seen. In group II, instead of placing the duodenoscope, a needle guided with the laparoscope was percutaneously punctured into the gall bladder. Five mL of bile was aspirated from the gall bladder. After that 5 mL of MCCP dye was injected. The bile ducts became blue.

RESULTS

In group I, thirteen cases were successfully illuminated and three failed. The cause of three failed cases was due to the difficulty in inserting the fiber into the ampulla of Vater. The time required for this examination ranged from 15 to 100 min with a median time of 35 min. No complications occurred in the thirteen successful cases. In each of these cases, the location of the common and hepatic ducts was seen clearly differentiating the ductal system from surrounding anatomy. In ten cases both the left and right hepatic ducts could be seen and in three only the right hepatic ducts were seen. In four of the thirteen cases, the cystic ducts were also seen. In two cases the ducts were clearly seen in spite of considerable fat over Calot's triangle.

In group II, eighteen of the twenty cases were successful.

The extrahepatic duct became blue differentiating the ductal system from surrounding anatomy. Two cases failed due to a stone obstructing the cystic duct, and extravisation of the dye turned the entire area blue.

DISCUSSION

Prevention of injury to the ductal system continues to be a matter of considerable concern of surgeons performing laparoscopic cholecystectomy. The accurate incidence of bile duct injury (BDI) during laparoscopic cholecystectomy (LC) is not known[1]. The principal causes of CBD in LC are the uncertain anatomy and the laparoscopic view that is quite different from open cholecystectomy. A few methods have been practiced, *e.g*. using 30° laparoscope, applying three dimensional laparoscope and inserting laparoscope through the right side of umbilicus were used. Greater efforts have been concentrated on dealing with the uncertain anatomy. The key point continues to be how to best identify the anatomy and thereby avoid injury. Currently the primary means of preventing injury resulted from uncertain anatomy include careful dissection, the judgment of an experienced surgeon, conversion to open cholecystectomy and intraoperative cholangiography (IOC).

The major causes of uncertain anatomy are anatomic variation and unclear anatomy. Kurumi *et al*.[2] classified confluent forms of the cystic duct and the bile duct into five different types, including four abnormal types. Sixteen instances (3.13%) of anatomic variation of the biliary tract were found among 511 patients, and four cases (4.35%) were found in 92 cadavers. Anatomic variation of the biliary tract is both common and complicated and can create a pitfall during laparoscopic cholecystectomy. Unclear anatomy resulted from inflammation and adhesion at Calot's triangle is an important factor associated with injury[3-5]. The judgment of an experienced surgeon[1,4,6] and conversion from laparoscopic to open cholecystectomy[5,7] are now considered the primary means of preventing bile duct injury resulted from uncertain anatomy. Unfortunately these means do not always work effectively. Injuries are likely to occur despite better procedures and increased experience[4]. Calvete *et al.* believed that no relation could be found between the experience of surgeons and the number of BDI over different periods of time[8]. Therefore, BDI during LC can not be attributed solely to the learning curve. One approach is to convert to open cholecystectomy when the anatomy is uncertain. But even open cholecystectomy can not avoid CBD injury due to the uncertain anatomy. Yang *et al*.[9] reported iatrogenic extrahepatic bile duct injury in 182 patients. Bile duct injury occurred in 152 patients during open cholecystectomy and in 30 patients during laparoscopic cholecystectomy. The incidence of BDI after LC was similar to that in the open procedure[1].

Cautious dissection is necessary and essential to prevent BDI in LC[4,6,10-12]. Illegible anatomy often poses dissection difficultly to operators and rends them quite helpless. Surgeons are seeking assisting measures to help them identify the anatomy during LC. Some surgeons recommended that IOC be attempted on all patients undergoing LC. They deemed that the routine use of IOC during laparoscopic cholecystectomy could not prevent bile duct injuries, but minimized the extent of the injuries so that they could be repaired easily, thus decreasing the rate of BDI[13-16]. But its routine use during LC remains controversial. Routine IOC yields very little useful clinical information compared to selective policies. A large number of unnecessary IOC were performed under routine IOC policy, and therefore a selective policy has been advocated[17]. IOC depends on the radiopaque dye introduced into the ductal system via the cystic duct and displayed by either a static film or fluoroscopy which does not always identify the relationship of the ductal system to adjacent anatomy. The primary purpose of IOC is to identify anatomy and any aberration as well as to identify stones. The image of IOC obtained from static film or fluoroscopy is completely different from that obtained from the monitor and can not really tell where the cystic duct or common bile duct is. The information afforded by IOC can only help operators realize if there are continuity, stones, tumor and injury of the ducts but can not help them dissect easily and safely. Thus it is of limited value during dissection of the area. Nevertheless it has become the most common method of visualizing the area.

The use of MCCP has been advocated by Xu *et al*.[18]. This technique does give a direct image but it is blurry. A mixture is got by injecting methylenum coeruleum into gall bladder. The color of the mixture is close to that of the tissue surrounding the extrahepatic duct, so that the bile ducts can not be identified clearly. The image is even more indistinct when there is much fatty tissue over the ducts. If there is extravasation, the entire area turns blue making dissection more difficult since the dye is not easily washed away. CBD does not keep the dye long enough. The dye diluted by the bile flows into duodenum soon, so that the operator can not observe Calot's triangle repeatedly. Finally, the procedure can not be used if the duct is blocked by a stone.

Because of these limitations of current methodologies, we advocated the new method of direct illumination of the extrahepatic ductal system (LCP). By adjusting the optic fiber, it can go into right or left hepatic duct and cystic duct. The movement of the fiber must be slow and soft. It is not very easy sometimes to insert the fiber into cystic duct for the duct may pass behind the common hepatic duct to enter on its posterior wall or on its left lateral aspect. If the inserting was difficult, we gave the attempt up in case that the duct wall was injured by the fiber. We do not think the illumination of cystic duct is absolutely necessary. The important thing is to know the locations of CBD and common hepatic duct, though the illumination of cystic duct may make the image of Calot's triangle appear completely.

Table 1 Comparison between group I and group II

	Group I (n=16)	Group II (n=20)
Examine method	LCP	MCCP
Examine time (min)		
Range	15-100	5-10
Median	35	7
Examination cost	$ 200	$ 5
Image	direct	direct
Legibility	clear	blurry
Observed time	unlimited	limited

Additional observations we made during this study revealed the importance of releasing any adhesions in the area of the ductal system to straighten the ductal system out facilitating the introduction of the optical fiber. The initial dissection of the ductal system along with our observations as to the probable location of the various elements was also helpful. In our opinion it is best to keep the optical fiber in the right hepatic duct until the dissection of the gall bladder and cystic duct is completed. This is particularly true in the occasional case when the cystic duct comes off the right hepatic duct. We do not feel routine LCP examination of the ductal system is indicated but in selected cases. The examination with LCP is extremely rewarding and not terrifically difficult in any hospital where the intraoperative endoscopic retrogarde cholangiopancreatography (ERCP) is practiced. As far as the cost is concerned, the increase is quite acceptable (Table 1). Of course, if there is any reason

for intraoperative ERCP to be done, it can be easily accomplished during LCP, though it needs not to be done as a routine. LCP can not help operators realize if there are continuity, stones, tumor and injury of the ducts. When the forgoing conditions are suspected, cholangiography should be done with intraoperative ERCP.

LCP is currently the most effective way to directly observe the extrahepatic ductal system during laparoscopic cholecystectomy and may play a useful role in clarifying uncertain anatomy in selected cases. As a useful assisting measure, it plays an important role in preventing extrahepatic duct injury in LC.

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