

Three-dimensional identification of the cystic infundibulum-cystic duct junction: a technique for identification of the cystic duct in laparoscopic cholecystectomy

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OBJECTIVE: The main cause of bile duct injury (BDI) at laparoscopic cholecystectomy is misidentification of the common bile duct as the cystic duct (CD). The aim of this article is to introduce a modified technique, i. e., three-dimensional identification of the cystic infundibulum (CI)-CD junction, to prevent misidentification-induced BDI during laparoscopic cholecystectomy.

METHODS: The CI was extensively dissected to expose its anterior, interior-superior and inferior-dorsal aspects. With the CI nearly circularly dissected out, the CI and the appearance-indicated CI-CD junction might be three-dimensionally identified and the reality of the CI-CD junction as well as the reality of the CD could be precisely judged.

RESULTS: Overall 10 BDIs were documented in this group. Since BDI occurred in 8 of 4382 patients receiving laparoscopic cholecystectomy, the technique for prevention of misidentification-induced BDI was established. Among the late batch of 7618 patients, only two BDIs were noted.

CONCLUSIONS: Three-dimensional identification of the CI-CD junction is a reliable, feasible and relatively low experience-dependent technique to prevent most of misidentification-induced BDI.

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Key words: laparoscopic cholecystectomy; common bile duct; bile duct injury

Introduction

The main cause of bile duct injury (BDI) at laparoscopic cholecystectomy is misidentification of the common bile duct (CBD) as the cystic duct (CD).^[1,2] Strategies for avoidance of the anatomic misjudgment-induced BDI have been recommended such as exposing the common hepatic duct

(CHD)-CBD-CD junction (tri-duct junction) to identify the CD,^[3,4] funds-to-neck technique, laparoscopic intraoperative cholangiography (LIOC). However, BDI is still occurring even in an uncomplicated laparoscopic cholecystectomy performed by an experienced performer or in those in which LIOC had been undertaken.^[1] The likely answers to these questions are that these techniques derived from open cholecystectomy for preventing BDI are not always reliable or feasible under laparoscope. Additionally, these approaches are highly experience-dependent. From September 1991 to April 2002, 12 000 patients underwent laparoscopic cholecystectomy at our hospital. Of the first batch of 4382 patients receiving laparoscopic cholecystectomy, 8 had BDI including misidentification of the

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CBD as the CD in 6 patients. The lessons from the 6 BDIs prompted us to modify the technique for judgment of the reality of the CD. In the subsequent batch of 7618 consecutive patients having laparoscopic cholecystectomy, only 2 BDIs were noted. This article aims to introduce this reliable, feasible and relatively low experience-dependent technique for prevention of misidentification-induced BDI.

Methods

Laparoscopic cholecystectomy was performed on 12000 patients with symptomatic gallstone or benign prominent lesions of the gallbladder, of whom 4226 were male and 7774 were female, aged 6–84 years. Four- or three-port access was applied for introduction of laparoscopic instruments. The posterior peritoneum covering the appearance-indicated “likely CI-CD junction” was incised to create a posterior peritoneum window, which was widened with an irrigation-suction cannula or an electrical hook to expose the “likely CI-CD junction” but not to skeletonize it. The interior-superior and inferior-dorsal borders of the CI were exposed as widely as possible to nearly circularly dissect out the CI. With the CI nearly circularly exposed, the anterior, interior-superior, and inferior-dorsal aspects of the CI could be observed, indicating three-dimensional identification of the CI-CD junction. Subsequent to three-dimensional exposure of the “likely CI-CD junction”, it is not difficult to recognize whether there was the duct-like structure above the interior-superior border of the CI joining the exposed CD, so the reality of the CI-CD junction as well as the reality of the CD could be judged.

Results

Of 10 patients with BDI documented in this series, 8 were among the 4382 patients. After use of this technique, misidentification-induced BDI was noted in only 2 of the 7618 patients receiving laparoscopic cholecystectomy. The causes of the 10 BDIs included anatomic misidentification-induced transection of the CBD (6 patients), division of the

CBD and distal CHD (2), and thermal injury to the extrahepatic bile duct (2). The overall incidence rate of BDI was 0.083%. The incidence rate of BDI in the 7618 patients was 0.026%.

Discussion

Reports^[5,6] have shown that BDI during laparoscopic cholecystectomy cannot be solely attributed to the learning curve. The latest case of BDI in this group occurred in a laparoscopic cholecystectomy performed by an operator who had experience with more than 2000 cases of laparoscopic cholecystectomy. Retrospective studies^[1,2] demonstrated that the most common mechanism for BDI is misidentification of the CBD as the CD, followed by division of the CBD and the distal CHD with or without clipping of the proximal CHD. In our group, misidentification of the CBD as the CD led to 8 of 10 BDIs including the latest one.

Identification of the CD through exposing the tri-duct junction is a standard technique in open cholecystectomy.^[3] In laparoscopic cholecystectomy era, the tri-duct junction has been re-adopted as a landmark for recognition of the CD. Katkhouda and colleagues^[4] recommended blunt dissection of the tri-duct junction as “visual cholangiography”. In some instances in which the extrahepatic bile duct lies within the slim hepatoduodenal ligament, the tri-duct junction can be readily exposed under laparoscope and applied as a reliable landmark for identifying the CD. Nevertheless, for other patients, the tri-duct junction would be difficult to identify. Moreover, extensive dissection of the hepatoduodenal ligament for exposing the tri-duct junction is potentially risky to the extrahepatic bile duct.^[7] Also, the CI-CD junction has been proposed by some authors as an alternative landmark for identification of the CD during laparoscopic cholecystectomy.^[7] The CI-CD junction is easier to be exposed laparoscopically. However, the problem is how to precisely confirm the reality of the CI-CD junction. The appearance-indicated “likely CI-CD junction” is probably the CI-CBD junction. Gallstone impacted at the CI or the very short CD is frequently encountered during laparoscopic cho-

lecystectomy. Under this circumstance, if the CBD was very slender, the appearance of the CI-CBD junction would be surprisingly similar to that of the real CI-CD junction. In these cases, even an experienced performer usually would not be suspicious of the reality of the "junction", and thus the false CI-CD junction would inevitably lead to misidentification of the CBD as the CD. We refer the anatomic combination of the very short CD and small-diameter CBD as "near Mirizzi syndrome" (NMS).

The anatomic implication of NMS is that the CI and CD have a closer relation with the extrahepatic bile duct in NMS than in common anatomic types of the extrahepatic biliary system. The appearance-indicated "CI-CD junction" is actually the CI-CBD junction and extremely easy to lead to a catastrophic misidentification of the CBD as the CD. Distinctive from classic Mirizzi syndrome, NMS may be independent of the severity of lesion of the gallbladder. That is why BDI would still occur even in a seemingly uncomplicated laparoscopic cholecystectomy carried out by an experienced operator. In the early cases of this series, the judgment of the CI-CD junction was mainly appearance-based. Anatomic misjudgment led to 8 of our 10 BDIs, of which 6 were associated with unrecognized NMS.

Another strategy for avoidance of BDI is LIOC. Routine LIOC has not been widely accepted because of its time-consuming and poor cost-effectiveness. As for selective LIOC, whether the present laparoscopic cholecystectomy is indicated for LIOC is frequently uneasy to be determined. In our 10 BDIs, either the original laparoscopic cholecystectomy was assessed as an "uncomplicated" one and LIOC was not attempted or LIOC could not be carried out because of the anatomic limitation of the CD. Additionally, several investigations^[1,6] have shown that BDI could still occur in patients who underwent LIOC.

BDIs in this series and the results of others indicated that: (1) the tri-duct junction is not an ideal structure for laparoscopic identification of the CD, at least for some individuals; (2) neither routine nor selective LIOC can completely prevent BDI; (3) the CI-CD junction is a technically feasible landmark for judgment of the CD; however,

the reality of the junction can not be simply judged as its appearance indicated laparoscopically.

The lesson from the 8 BDIs of this series prompted us to adopt a modified technique for judgment of the reality of the CI-CD junction and the CD, that is wide dissection of the CI for a three-dimensional identification of the CI-CD junction.

In our practice, hepatoduodenal ligament and CI were closely observed for an anatomic "first impression" before any dissection. In nearly half individuals, anatomic relations of the extrahepatic biliary system could be visualized through the hepatoduodenal ligament and handling of the CD is rather easy. Whenever the extrahepatic bile duct could not be visualized through the hepatoduodenal ligament, the proximal CI was extensively dissected to judge the reality of the CD. After the dissection, the "likely CI-CD junction" could be circularly freed, and the initial appearance-indicated "likely CI-CD junction" could be identified on the basis of three-dimensional observation. That is so-called three-dimensional identification of the CI-CD junction.

The anatomic bases of our technique include: ① no matter what type of anatomic aberrance of the extrahepatic biliary tract exists, the continuity between the CBD and CHD is unchanged; and ② when the CBD is misjudged as the CD, the distal CHD lying in the Calot triangle and joining the wrongly exposed proximal CBD after extensive dissection of the CI, should be recognized above the interior-superior border of the CI.

Because of the continuity of the extrahepatic bile duct, the reality of the CD can be confirmed when the CI-CD junction is three-dimensionally exposed while no duct-like structure superior to the interior-superior border of the CI joins the exposed CD. In the presence of NMS, the appearance-indicated "CI-CD junction" is actually the CI-CBD junction. By three-dimensionally exposing the "CI-CD junction", operators can recognize that the exposed "CD" is in continuity with the duct-like structure (the distal CHD) presenting above the interior-superior border of the CI. Thus, the appearance-indicated "likely CI-CD junction" can be readily identified as the CI-CBD junction and mis-

dentification-induced BDI may be prevented. In our 7618 cases of laparoscopic cholecystectomy, the CBD was misidentified as the CD in 6 cases in initial manipulation. With the CI-CD junction three-dimensionally exposed, the distal CHD above the interior-superior border of the CI and in continuity with the "CD" was clearly detected. After painstaking dissection of the distal CI, the very short real CD was recognized and thus impending misidentification-induced BDI was prevented. Unfortunately, in the 8641th and 10271th cases of laparoscopic cholecystectomy, without dissection of the CI, we misidentified the CBD as the CD and made the latest 2 cases of BDI of this series.

Bulky gallstone impacted at the CI may add additional trouble to wide exposure of the CI. Frequently, decompression of the gallbladder is needed. The big impacted gallstone might translocate to the cystic body and the CI might be firmly held with a grasping forceps. With the CI pulled laterally, visualization of the Calot triangle and the interior-superior aspect of the CI could be improved. Then, the CI can be dissected out as it does in common cases.

In case of the CI-CD junction embedded in dense adhesion, the CI-CD junction could not be judged and the safety of laparoscopic cholecystectomy could not be insured even with the approaches described above. Under these circumstances, intraoperative imaging techniques such as laparoscopic ultrasound^[8] are required to demonstrate anatomy of the extrahepatic biliary tract, or a conversion to open cholecystectomy is indicated.

Competing interest

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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