

Application of fluorescent cholangiography for determination of the resection line during a single-incision laparoscopic cholecystectomy for a benign lesion of the cystic duct : - Preliminary experience -

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ABSTRACT

Background: To avoid bile leakage from the stump of a cystic duct that is closed at edematous and/or involved areas, the decision regarding the location of the resection line during a laparoscopic cholecystectomy for benign lesions extending into the cystic duct is important and requires technical ingenuity. For these situations, we used fluorescent cholangiography.

Methods: Our procedure for single-incision laparoscopic cholecystectomy utilized the SILS-Port, and an additional pair of 5-mm forceps was inserted via an umbilical incision. As a fluorescence source, 1 mL of indocyanine green was intravenously injected after endotracheal intubation of patients in the operating room. A laparoscopic fluorescence imaging system developed by Karl Storz Endoskope was utilized for fluorescent cholangiography.

Results: Fluorescent cholangiography could be used to identify the border of the lesion in the cystic duct. According to the fluorescent cholangiography results, a location for the resection line of the cystic duct could be identified; therefore, the planned resection was successful and produced a histologically negative margin.

Conclusions: Application of fluorescent cholangiography in the determination of the location of the resection line location during a laparoscopic cholecystectomy for benign lesions of the cystic duct should be widely accepted.

INTRODUCTION

Adequate closure of the cystic duct is an important procedure to avoid of bile leakage after a laparoscopic cholecystectomy^{1,2}. Additionally, closure of the cystic duct at edematous and/or involved areas is reason for bile leakage from the stump of the cystic duct^{1,2}. For complete resection of the lesion extending into the cystic duct, the placement of the resection line of the cystic duct during a laparoscopic cholecystectomy requires technical ingenuity. In this situation, the confluence between the cystic duct and common hepatic duct is exposed under a laparoscopic view, and the cystic duct is cut at the confluence. However, these procedures include a potential risk of biliary injury. When direct cholangiography is performed to determine the location of the resection line of the cystic duct, it carries a potential risk of disseminating the tumor and/or leaving a residual lesion; therefore, direct cholangiography is an unsuitable procedure. Recently, the clinical value of fluorescent cholangiography during a laparoscopic cholecystectomy has been increasingly reported, and this procedure has been deemed comparable to direct cholangiography³⁻⁸.

Herein, we describe our experience with the application of fluorescent cholangiography for determining the placement of the resection line during a single-incision laparoscopic cholecystectomy for benign lesions of the cystic duct and the successful completion of the resection.

METHODS

Surgical procedure for single-incision laparoscopic cholecystectomy

Based on our previous reports⁹⁻¹², a single-incision laparoscopic cholecystectomy was performed. After a single 2 to 2.5-cm long vertical incision had been made across the umbilicus, the SILS-Port (Covidien, Mansfield, MA, USA) was placed through the umbilical incision. A 5-mm flexible scope (Olympus, Tokyo, JAPAN) was inserted through the port to explore the abdominal cavity via a 12-mmHg pneumoperitoneum produced with carbon dioxide. An additional pair of 5-mm forceps was inserted through the umbilical

incision outside the SILS-Port to lift the fundus of the gallbladder. After dissection of Calot's triangle, the cystic artery was separated from the cystic duct. The cystic artery and the cystic duct were cut using 2 to 3 clips after obtaining a "critical view of safety"¹³. Once the gallbladder had been dissected from the gallbladder bed, the specimen inside the retrieval bag was removed through the umbilical incision. The umbilical incision was carefully closed without placing any drainage tubes.

Fluorescent cholangiography techniques

Based on our previous report¹², fluorescent cholangiography was performed. As a fluorescent source, 1 mL of indocyanine green (2.5 mg/mL of Diagnogreen; Diichi Sankyo Co., Tokyo, Japan) was intravenously injected after endotracheal intubation of the patient in the operating room. A D-light P-light-source unit (Karl Storz Endoskope, Tuttlingen, Germany) with the ability to alternate between a xenon and infrared light using a foot pedal served as a laparoscopic fluorescence imaging system via a 12-mm port inside of the SILS-Port. A filter was placed on a 30-degree, 10-mm laparoscope, which when activated, captured only the fluorescent image reflected by the dye. Before and after the dissection of Calot's triangle, fluorescent cholangiography was routinely recorded to visualize the anatomical structures and the extent of disease in the cystic duct. In addition, after removal of the gallbladder, fluorescent cholangiography was routinely recorded to check for bile fistulas and biliary injury. When further anatomical visualization was deemed necessary, fluorescent cholangiography was repeated.

RESULTS

We used fluorescent cholangiography to determine the location of the resection line of the cystic duct during single-incision laparoscopic cholecystectomies in patients with gallbladder adenomyomatosis that extended into the cystic duct (Figure 1A and 1B).

After dissection of Calot's triangle, the border of the lesion in the cystic duct was successfully visualized (Figure 1C and 1D). The resection line of the cystic duct was

determined according to the fluorescent cholangiography findings (Figure 1D). The planned resection was successful and produced a histologically negative surgical margin (Figure 1E and 1F).

DISCUSSION

A laparoscopic cholecystectomy has been recognized as a suitable procedure for benign disease of the gallbladder¹⁻¹³. When this disease extends into the cystic duct, closure of the cystic duct at the edematous and/or involved areas can result in bile leakage from the stump of the cystic duct after a laparoscopic cholecystectomy^{1,2}. Accordingly, the cystic duct should be closed in an area without any lesions, but the determination of the location of the resection line of the cystic duct is technically demanding. To avoid biliary injury during exposure of the confluence of the cystic duct and the common hepatic duct while performing complete resection of the cystic duct, direct cholangiography has been widely accepted as a method to determine the location of the resection line of the cystic duct. However, direct cholangiography carries a potential risk of disseminating the tumor and/or leaving a residual lesion. Recently, the clinical value of fluorescent cholangiography during a laparoscopic cholecystectomy has been considered to be equivalent to that of a direct cholangiography^{3-8,12}. Fluorescent cholangiography does not produce a risk of dissemination; therefore, fluorescent cholangiography is superior to direct cholangiography.

Regarding the technical procedure for determining the placement of the resection line of the cystic duct using fluorescent cholangiography, one drawback of fluorescent cholangiography has been noted^{3-8,12}. Fluorescent cholangiography cannot identify biliary structures covered by surrounding organs; therefore, cystic ducts with wall thickening due to benign lesions have been noted as absent when fluorescent cholangiography was used (Figure 1C and 1D). In contrast, cystic ducts without wall thickening are well visualized under fluorescent cholangiography (Figure 1C and 1D). According to these findings, fluorescent cholangiography could facilitate determination of the resection line of the cystic duct and lead to successfully accomplishing the planned surgery. Consequently, fluorescent

cholangiography is superior to direct cholangiography for the determination of the location of the resection line of the cystic duct.

Additionally, clinical reports regarding laparoscopic surgery for early stage gallbladder carcinoma have increased ¹⁴⁻¹⁶. In these surgeries, fluorescent cholangiography can theoretically be used to determine the location of the resection line of the cystic duct without bile spillage; therefore, the use of fluorescent cholangiography may be a suitable procedure for early stage gallbladder carcinoma.

In conclusion, application of fluorescent cholangiography to determine the location of the resection line of the cystic duct during a laparoscopic cholecystectomy for benign lesions of the cystic duct is an easy and suitable procedure. The clinical value of fluorescent cholangiography during a laparoscopic cholecystectomy for early stage gallbladder carcinoma requires further investigation.

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Figure Legends

Figure 1: Case presentation

A 48-year-old woman was diagnosed with adenomyomatosis of the gallbladder with gallstones. We planned a single-incision laparoscopic cholecystectomy. The resection line was determined by the findings of fluorescent cholangiography, and the planned surgery was successful. The operative time and intraoperative blood loss were 84 minutes and 2 mL, respectively. The patient was discharged from our hospital 3 days after surgery.

A: Computed tomography with contrast enhancement shows diffuse thickening of the gallbladder wall with gallstones (arrowheads).

B: Computed tomography with contrast enhancement revealed that the thickening of the gallbladder wall extended to the cystic duct (black solid arrow).

C: Under a normal laparoscopic view, the border of the lesion in the cystic duct (white solid arrow) cannot be identified.

D: Under fluorescent cholangiography, the border of the lesion in the cystic duct was well visualized (white broken arrows).

E: The macroscopic findings of the resected specimen show diffuse thickening of the gallbladder wall.

F: The histological findings of the stump of the cystic duct reveal no abnormal lesions.