

What is the Safe Training to Educate the Laparoscopic Cholecystectomy for Surgical Residents in Early Learning Curve?

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Purpose: This study was conducted to investigate the safety of laparoscopic cholecystectomy (LC) performed by surgical residents.

Methods: We reviewed the records of patients who underwent LC for chronic cholecystitis and gallbladder polyps between February 2010 and July 2012. All diagnoses were confirmed by biopsy. All procedures performed by surgical residents were conducted under the close supervision of an experienced laparoscopic surgeon. A standard four-port method was used, and we achieved the critical view of safety in almost all patients.

Results: Of 219 LC procedures, 136 were performed by an experienced laparoscopic surgeon, and 83 by surgical residents. There was no significant difference in postoperative hospital stay (1.1 vs. 1.2 days, $p=0.337$) or complication rates (3.7% vs. 2.4%, $p=0.712$) between groups. However, the patients operated on by surgical residents had significantly longer operation times (40.7 vs. 63.7 min, $p<0.05$).

Conclusion: LC performed by inexperienced surgical residents under the supervision of an experienced surgeon is safe and feasible for chronic cholecystitis and gallbladder polyps. Major bile duct injury is strongly correlated with having performed fewer than 20 LC procedures, so surgical residents must secure the critical view of safety, and the supervising surgeon must confirm it before the cystic duct and cystic artery are ligated.

Keywords: Laparoscopic cholecystectomy, Biliary, Training, Surgical resident, Complication

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Received April 18, 2016

Revised May 31, 2016

Accepted June 3, 2016

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INTRODUCTION

Laparoscopic cholecystectomy (LC) is the most frequently performed operation on the digestive tract, and it is essential for surgical residents to acquire the necessary skills to perform the procedure safely. However, inexperienced surgeons are reluctant to perform it because of the risk of bile duct injury.

The rate of major bile duct injury is higher during LC than during open cholecystectomy (0.4~0.7% vs 0.2%)¹ and is strongly correlated with surgical inexperience and having per-

formed fewer than 20 LC procedures. Michael et al.² reported that 90% of biliary injuries occurred during the first 30 LC procedures. Visual misperception is the most common cause (97%) of iatrogenic bile duct injuries, while lack of technical skill or knowledge accounts for only 3%.³ The most common injury is complete transection of the common bile duct. For this reason, adequate training of surgical residents is crucial.

The aim of our study was to investigate the safety of laparoscopic cholecystectomy performed by surgical residents, and to discuss the most appropriate methods of training.

MATERIALS AND METHODS

We reviewed retrospectively the records of 219 consecutive patients who underwent LC for chronic cholecystitis and gallbladder polyps between February 2010 and July 2012, in Hanyang University Seoul Hospital. All 219 LC procedures used a four-port technique; we excluded all cases of single- or three-port LC. The residents did not operate on patients with acute cholecystitis or gallbladder empyema because such cases tend to be hyperemic and edematous. The supervisors selected the cases appropriate for the surgical residents, with cases with severe inflammation and anatomical variation on preoperative CT also being excluded. The supervisors directed the residents to operate on many cases in which an endoscopic nasobiliary drainage (ENBD) catheter had been inserted after preoperative endoscopic retrograde cholangiopancreatography (ERCP) for suspected common bile duct stones, since the catheter facilitated identification and securing of the common bile duct. The patients were divided into two groups according to the

surgeons involved: 136 LCs were performed by a hepatobiliary surgeon, and 83 by 10 surgical residents (range: 1 to 19).

All the surgical residents were senior residents who had participated at least 50 laparoscopic appendectomies or LC procedures as operators or scopists, so that they had already developed basic laparoscopic skills. All the procedures performed by them were carried out under the close supervision and guidance of an experienced laparoscopic surgeon. The supervisors were two surgeons who performed at least 250 LC per year. The supervisors were often observers, and sometimes scopists. The supervisor confirmed the critical view of safety (CVS) in every case, by checking the site between dissected cystic duct and gallbladder. Additional examinations including cholangiograms were not carried out since the CVSs were secured.

SPSS 17.0 software (Chicago, IL, USA) was used for statistical analysis. The chi-square and Fisher's exact tests were used for categorical variables, and Student's t-test for continuous variables. Values of $p < 0.05$ were considered statistically significant.

Table 1. Comparison of pre-operative general characteristics and surgical outcomes

| Pre-operative characteristics | Operator | | Total (n=219) | p |
|-------------------------------------|--------------------------|--------------------------|--------------------------|--------|
| | Surgeon (n=136) | Resident (n=83) | | |
| Age, years | 51.1 (\pm 13.9) | 53.8 (\pm 11.5) | 52.1 (\pm 13.0) | 0.140 |
| Male to female ratio | 1.3 | 0.9 | 1.2 | 0.187 |
| Body mass index, kg/m ² | 24.9 (\pm 3.7) | 24.7 (\pm 3.0) | 24.8 (\pm 3.4) | 0.651 |
| White blood count, /mm ³ | 7,199.3 (\pm 2,324.2) | 6,955.4 (\pm 2,583.0) | 7,110.9 (\pm 2,412.3) | 0.471 |
| Total bilirubin, mg/dL | 1.2 (\pm 2.1) | 1.3 (\pm 1.7) | 1.2 (\pm 1.9) | 0.768 |
| Alkaline phosphatase, U/L | 92.7 (\pm 73.7) | 100.4 (\pm 122.0) | 95.5 (\pm 94.3) | 0.561 |
| Aspartate aminotransferase, U/L | 76.5 (\pm 139.5) | 70.4 (\pm 101.2) | 74.0 (\pm 126.0) | 0.726 |
| Alanine aminotransferase, U/L | 85.8 (\pm 152.0) | 79.0 (\pm 129.1) | 82.9 (\pm 143.0) | 0.736 |
| Critical view of safety, n (%) | 134 (98.5) | 82 (98.8) | 216 (98.6) | 1.000 |
| ERCP, n (%) | 23 (16.9) | 20 (24.1) | 42 (19.6) | 0.194 |
| Pancreatitis, n (%) | 2 (1.5) | 3 (3.6) | 5 (2.3) | 0.370 |
| Diabetes Mellitus, n (%) | 17 (12.5) | 10 (12.0) | 27 (12.3) | 0.921 |
| Hypertension, n (%) | 23 (16.9) | 18 (21.7) | 41 (18.7) | 0.379 |
| Surgical outcomes | Operator | | Total (n=219) | p |
| | Surgeon (n=136) | Resident (n=83) | | |
| Operation time, minutes | 40.7 (\pm 11.4) | 63.7 (\pm 16.8) | 49.5 (\pm 17.7) | <0.001 |
| Post-operative stay, days | 1.1 (\pm 0.4) | 1.2 (\pm 0.6) | 1.1 (\pm 0.5) | 0.337 |
| Hospital stay, days | 3.6 (\pm 3.0) | 4.1 (\pm 3.4) | 3.8 (\pm 3.1) | 0.182 |
| Complication, n (%) | 5 (3.7) | 2 (2.4) | 7 (3.2) | 0.712 |

ERCP = endoscopic retrograde cholangiopancreatography.

RESULTS

Of the 219 LC procedures, 136 were performed by the experienced laparoscopic surgeons, and 83 by the surgical residents. The demographic characteristics and laboratory findings were similar in the two groups. There was no significant difference in postoperative hospital stay (1.1 vs 1.2 days, $p=0.337$) or complication rate (3.7% vs 2.4%, $p=0.712$) between the patients operated on by experienced surgeons and surgical residents. However, the patients who underwent LC by the surgical residents had significantly longer operation times (40.7 vs 63.7 min, $p<0.05$) (Table 1).

Complications occurred in 5 cases that were operated on by supervisors, and 2 cases operated on by residents. All of them were wound seroma or infections; no major complications, including bile duct injury, occurred.

There were no instances of conversion during the study period. The operator was changed during one LC performed by a surgical resident because of difficulty achieving the CVS. During two LCs performed by an experienced surgeon and one by a surgical resident the CVS could not be achieved, and the common bile duct was confirmed visually.

DISCUSSION

While LC is a basic general surgical procedure, it carries the risk of bile duct injury. Therefore, adequate training of surgical residents is essential. Archer et al.⁴ reported that residency training decreases the likelihood of injuring to the bile duct.

A variety of training methods have been proposed, such as training on animals⁵ and, in recent years, using a virtual reality simulator.⁶⁻⁸ In our hospital, there is no LC-specific

training system for surgical residents. However, the LCs in our study were performed by third or fourth year residents who had carried out at least ten laparoscopic appendectomies and had participated in at least ten LC procedures as scopists.

The operation was the entire dissection of hepatocystic triangle, exposing the cystic duct and artery, the infundibulum of the gallbladder, and the junction of the gallbladder and cystic duct before division of the cystic duct and artery.

Use of the CVS technique has been advocated to prevent complete transection of the common bile duct (Fig. 1).⁹ During the operation a few surgical residents tried to ligate the cystic duct before CVS had been attained. They said that ligating the cystic duct which is in front of Calot's triangle would have made the operation easier. The supervisor had to warn them in each case that unconfirmed CVS could lead to ligation of the common bile duct instead of the cystic duct.

In 1924 Henri Rouviere¹⁰ identified a sulcus that has come to be used as a landmark in cholecystectomy to help identify a safe dissection line.¹¹⁻¹³ Dissection ventral to Rouviere's sulcus has been associated with minimal incidence of common bile duct injury (Fig. 2).^{11,14}

Way et al.³ suggested that illusions of visual perception, to which everyone is susceptible, are the primary cause of laparoscopic biliary injuries, and that laparoscopic procedures should be standardized. The surgical residents in our study performed LC by following prescribed steps. First, the dissection line was identified using Rouviere's sulcus and the falciform ligament. Using a dissector, the posterior and then the anterior side was dissected. To prevent thermal injury, Bovie use was minimized. Once the cystic duct had been identified, Calot's triangle was dissected completely. The surgical residents had to secure CVS, and the supervising surgeon had

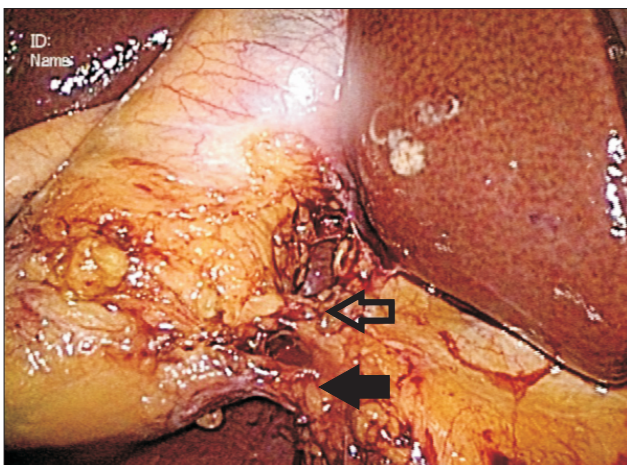


Fig. 1. Critical view of safety (filled arrow: cystic duct, empty arrow: cystic artery).

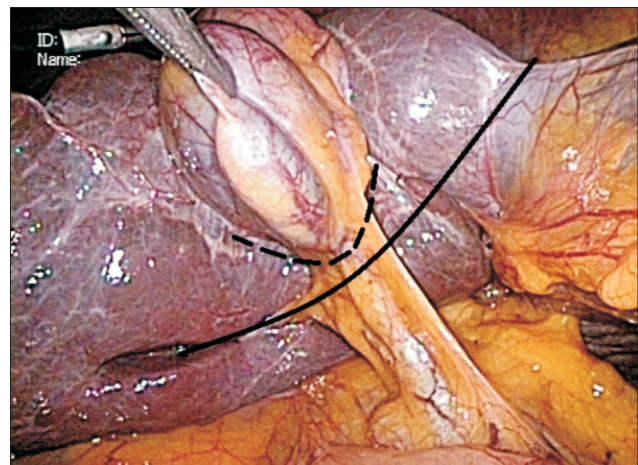


Fig. 2. Rouviere's sulcus and the dissection line (solid line: Rouviere's sulcus plane, dotted line: dissection plane).

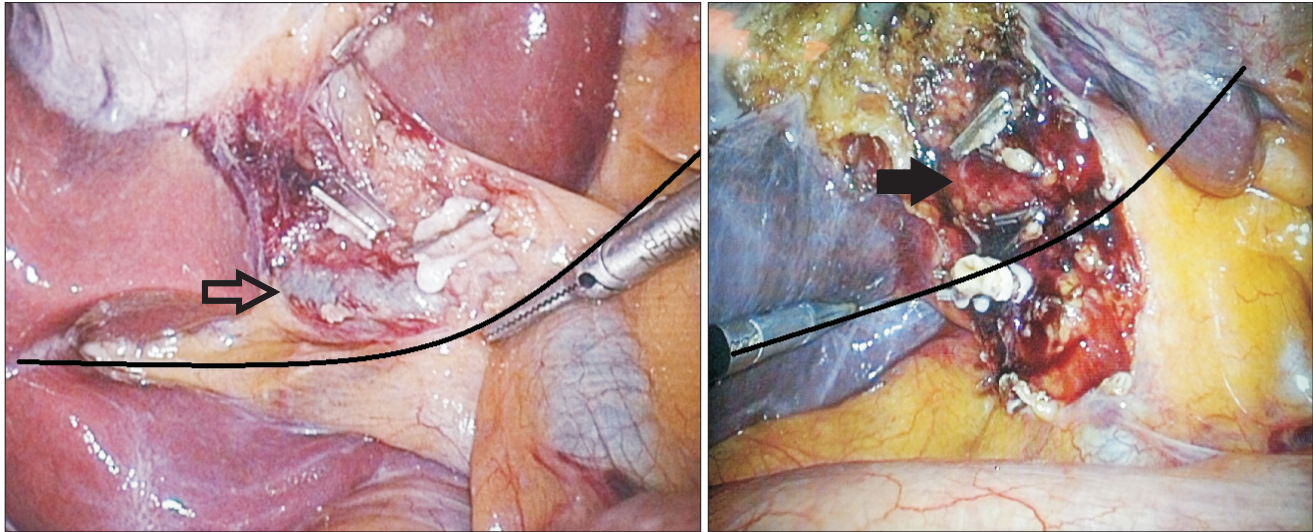


Fig. 3. Anterior branch of right hepatic duct and right hepatic artery place above Rouviere's sulcus plane (solid line: Rouviere's sulcus plane, empty arrow: anterior branch of right duct, filled arrow: right hepatic artery).

to confirm it before ligating the cystic duct and cystic artery. After ligation, dissection was performed close to the GB. Because energy devices, such as the harmonic scalpel, may disrupt the dissection plane, they were not used.

The most important considerations in relation to operations performed by surgical residents are the following. The most important initial step is deciding on the correct dissection line. In that step, it is important to confirm Rouviere's sulcus. The second step is securing the "critical view of safety" while minimizing the use of a Bovie to dissect Calot's triangle. In this step, we should not carry out unnecessary control of bleeding. The third is deciding on the line for dissecting the hepatocystic triangle after ligation of the cystic duct and cystic artery. If we decide on the wrong dissection line, the chance of injury to the right hepatic duct, right portal vein or right hepatic artery will increase. The dissection line must be close to gallbladder because right hepatic duct or artery often place above Rouviere's sulcus (Fig. 3). When surgical residents are operating under supervision they often make the wrong decision, and it is essential that the supervisor intervene at that point.

In conclusion, laparoscopic cholecystectomy can be performed safely by supervised residents, with outcomes similar to those obtained by experienced attending surgeons. Major bile duct injury is strongly correlated with having performed fewer than 20 LC procedures, so surgical residents must achieve the "critical view of safety", and the supervising surgeon must confirm it, before the cystic duct and cystic artery are ligated.

Supervisors should help to decide on the correct dissection

line and intervene to check unnecessary bleeding control using a Bovie, and they must confirm the CVS in early learning curve period.

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