Single-Incision Multiport Laparoscopic Cholecystectomy

Things to Overcome

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Objectives: To report on our initial experience with single-incision multiport laparoscopic cholecystectomy, together with its clinical outcomes.

Design: Nonrandomized prospective study.

Setting: University department of surgery.

Patients: Sixty-four patients with gallstones and gallbladder polyps were enrolled after providing informed consent. Based on our experience, we excluded patients with acute cholecystitis, concomitant choledocholithiasis, a history of previous upper abdominal surgery, and a suspicion of gallbladder cancer.

Main Outcome Measures: We analyzed the outcomes and complications, based on our experience, according to the clinicopathologic and operative factors. We also compared patients who underwent single-incision multiport laparoscopic cholecystectomy with those who were converted to conventional laparoscopic cholecystectomy.

Results: There were 2 bile duct injuries and 4 surgical site infections. We had difficulties in visualizing the Calot triangle in 22 patients. Higher levels of inflammatory markers, longer operation times, and more frequent bile juice spillage were significantly observed in those patients. Ten patients were converted to conventional laparoscopic cholecystectomy. The mean age of patients who underwent conversion surgery was significantly older than that of the no-conversion group. The more the body mass index increased, the more the conversion rate increased.

Conclusions: Experienced laparoscopic surgeons can safely perform cholecystectomy using conventional and curved laparoscopic instruments in selected patients. We recommend that you consider performing conventional laparoscopic cholecystectomy or that you use additional retraction devices for patients with a higher body mass index or acute cholecystitis.


LAPAROSCOPIC CHOLECYSTECTOMY is the criterion standard for the treatment of benign gallbladder diseases, and it is the most common laparoscopic surgery worldwide.1 Surgeons are performing more minimally invasive surgical techniques because of the well-recognized advantages of laparoscopic surgery, including better cosmetic results, less postoperative pain, and a faster recovery and return to normal life.2 These efforts have led surgeons to find ways to reduce the number and size of the incisions or to eliminate skin incisions in the case of natural orifice transluminal endoscopic surgery.3 However, intraperitoneal infection from an iatrogenic visceral scar and the technological limitations prevent the use of natural orifice transluminal endoscopic surgery in clinical practice.4 Navarra et al,5 in 1997, performed the first laparoscopic cholecystectomy using 2 transumbilical trocars and 3 transabdominal gallbladder stay sutures, and single-incision multiport laparoscopic surgery has recently become a focus of minimally invasive surgery. We can perform scarless surgery with the conventional laparoscopic instruments during single-incision multiport laparoscopic surgery.6 However, the advantages of this type of procedure over standard laparoscopic surgery, other than cosmesis, have not been determined, although 1 retrospective study7 showed a benefit for reduced pain. We have no consensus on the surgical techniques and exclusion criteria for this single-incision procedure in clinical prac-

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tice. Herein, we describe our initial experience with 64 patients who underwent single-incision multiport laparoscopic cholecystectomy. We report on the clinical outcomes of this procedure, and we determined the exclusion criteria based on our experience.

**METHODS**

**PATIENTS**

We prospectively documented and subsequently analyzed data from 64 patients who underwent single-incision multiport laparoscopic cholecystectomy for gallstones and gallbladder polyps at the Division of Hepatobilipancreas, Department of Surgery, Korea University Guro Hospital, between January 1, 2009, and June 30, 2009. Informed consent was obtained from all the patients. We planned to exclude patients with acute cholecystitis, concomitant cholecdocholithiasis, a history of upper abdominal surgery, and the suspicion of gallbladder cancer on imaging studies. Ten of 64 patients were converted to conventional laparoscopic cholecystectomy. We compared patients who underwent single-incision multiport laparoscopic cholecystectomy (the no-conversion group) with patients who were converted to conventional laparoscopic cholecystectomy (the conversion group) according to the patient’s age, sex, operation time, complications, histopathologic results, and duration of hospital stay after surgery.

**OPERATIVE STEPS AND SKILLS**

Patients were placed in the supine position using general endotracheal anesthesia; the abdominal cavity was accessed using a 10-mm rigid or flexible telescope via an umbilical 12-mm trocar with a transumbilical or periumbilical incision. The patient was then placed right side up in the reverse Trendelenburg position. When we decided to perform the single-incision multiport surgery, the incision was extended to a 2-cm length. The tips of the middle, index, and ring fingers of a No. 8 surgical glove were cut away, and a 12-mm trocar and two 5-mm trocars were placed into the glove’s respective fingers and then tied. An Alexis wound retractor (Applied Medical, Rancho Santa Margarita, California) and the glove with trocars were used as a single port (Figure 1). Carbon dioxide gas was insufflated into a 12-mm trocar with 12 mm Hg of intra-abdominal pressure. A 30\° rigid 10-mm telescope with a vertical light cable or a flexible 10-mm telescope with a coaxial light cable (Olympus, Tokyo, Japan) was used. Standard laparoscopic instruments and reticulating instruments (an L-hook electocautery and dissector) (CambridgeEndo, Framingham, Massachusetts) were used (Figure 2). After inserting the laparoscopic instruments into the abdominal cavity, retrieving the trocars from the fascia allows us to create space and increase the range of motion of instruments for performing the cholecystectomy. Antegrade dissection was usually performed, and retrograde dissection was performed for patients who had difficult exposure of the cystic duct and artery. The cystic and common bile ducts were identified using a laparoscopic grasper to retract the fundus, and the position of the dissection was assessed. We tried to obtain the critical view of safety for patients who had difficult exposure of the cystic duct and artery. First, we exchanged the position of the laparoscopic instruments. When the fundus was retracted using a grasper and the surgeon’s right hand via the right-sided trocar, we exchanged the position of each instrument and retracted the gallbladder using the surgeon’s left hand via the left-sided trocar. Exchanging the position of the instruments could provide new sights for identifying the Calot triangle. Second, we performed medial dissection between the gallbladder and the liver and then confirmed the absence of the bile duct from the gallbladder to the liver. Third, retrograde dissection was performed to obtain the safe dissection. The cystic artery was clipped using 5-mm endoclips (Endo Clipp; Covidien Autosuture, Mansfield, Massachusetts), and then it was divided. The cystic duct was clipped using a 5-mm ligating clip (Hem-o-lok; Weck Closure Systems, Research Triangle Park, North Carolina) and a 5-mm endoclip, and then it was divided. Occasionally, the cystic duct was ligated using a laparoscopic ligation device (OpenLoop; Sejong Medical, Paju, Korea). When the gallbladder was freed from its bed, the gallbladder specimen in an Endobag was retrieved from the abdominal cavity and then grasped using a Kelly clamp in the surgical glove. After warm saline irrigation and careful hemostasis, the surgical glove with the trocars and the Endobag with the specimen were removed. The wound retractor was removed, and the umbilical incision was closed in layers (Figure 3).

**STATISTICAL ANALYSIS**

The \( \chi^2 \) test was used for qualitative variables, the \( t \) test was used for quantitative variables, and the Mann-Whitney test was used for nonparametric quantitative variables to compare between the 2 groups. Univariate and multivariate logistic regression analyses were used to determine the effect of multiple risk factors on conversion to conventional laparoscopic cholecystectomy. \( P < .05 \) was considered statistically significant.

**RESULTS**

**CLINICAL CHARACTERISTICS AND OUTCOMES**

Of the 64 patients, 24 were men and 40 were women. The mean (SD) age of the patients was 47.0 (13.3) years.
The mean (SD) body mass index (BMI) (calculated as weight in kilograms divided by height in meters squared) was 23.9 (3.1). The preoperative inflammatory marker levels were within the reference ranges for almost all the patients: the median erythrocyte sedimentation rate (ESR) was 20.5 mm/h (25th-75th percentile, 0.16-89.22 mm/h), the median C-reactive protein (CRP) level was 0.81 mg/L (25th-75th percentile, 0.48-1.57 mg/L) (to convert to nanomoles per liter, multiply by 9.524), and the mean (SD) white blood cell count was 6275/µL (1819/µL) (to convert to $/H_10^9$, multiple by 0.001). Eighteen patients were asymptomatic, and abdominal ultrasonography was

Figure 2. A and B. Standard laparoscopic instruments and reticulating instruments were used. A 30° rigid 10-mm telescope with a vertical light cable or a flexible 10-mm telescope with a coaxial light cable was used as an optical device.

Figure 3. The single-incision multiport laparoscopic cholecystectomy procedure is described. A. During retraction of the body of the gallbladder, we identify the point of dissection. B. Antegrade dissection shows the cystic duct and artery. C. The cystic duct and artery are divided by using endoclips and ligating clips (Hem-o-loks; Weck Closure Systems, Research Triangle Park, North Carolina). D. After we divide the cystic artery, the gallbladder is detached from the liver using a hook electrocautery.
the primary imaging study for all the patients. The mean (SD) operation time (from skin incision to skin closure) was 91.9 (31.1) minutes. The pathologic reports revealed cholelithiasis (n = 50), gallbladder polyps (n = 7), gallbladder adenomas (n = 6), acute cholecystitis (n = 3), adenocarcinoma (n = 1), chronic cholecystitis (n = 52), and cholesterosis (n = 9). The adenocarcinoma, which developed from a gallbladder polyp, was confined to the lamina propria, and the patient has been observed by regular examinations. Ten patients (16%) were converted to conventional laparoscopic cholecystectomy, and 1 additional trocar at the epigastrium was used in half of the patients. The mean (SD) duration of the postoperative hospital stay was 2.3 (1.7) days. Bile juice spillage during the operation was observed in 18 patients (28%). Complications occurred in 6 patients (9%): 2 bile duct injuries and 4 surgical site infections. The bile duct injuries (3%) were classified as types C and E.

One was the injury of a suspected accessory right posterior hepatic duct, and this was found after cystic duct division. Clipping of the bile duct was performed because the transected duct was of a small diameter and was an accessory duct. The patient had no clinical symptoms, and there has been no sequelae until now. The other injury was transection of the common bile duct, discovered after discharge. The patient noted mild nausea during the postoperative period, yet nothing was noticed on physical examination, laboratory findings, and postoperative abdominal computed tomography. The patient then visited the outpatient department because of abdominal distention, nausea, vomiting, and poor oral intake. Abdominal computed tomography showed a large fluid collection in the abdominal cavity. We performed endoscopic retrograde cholangiopancreatography, and this showed the image of the cutoff common bile duct; therefore, Roux-en-Y hepaticojejunostomy was performed. The patient is doing well without any other complications. The surgical site infections (n = 4, 6%) were all superficial, and the patients were treated without complications at the outpatient department.

ANALYSIS OF PATIENTS WITH DIFFICULTIES IN OBTAINING THE CRITICAL VIEW OF SAFETY

We obtained the critical view of safety in 44 patients (69%, the easy group) and had difficulties in visualizing the Calot triangle in 22 patients (31%, the difficult group). Most patients in the difficult group eventually were secured for the safety view, but the others were converted to conventional laparoscopic cholecystectomy. The mean (SD) operation time in the easy group (85.3 [26.8] minutes) was shorter than that in the difficult group (106.3 [35.6] minutes, P = .01). The mean (SD) ESR (32.4 [15.2] mm/h) and the mean CRP level (13.0 mg/L; 25%-75%, 0.75-9.89 mg/L) in the difficult group were higher than those in the easy group (ESR, 21.9 [18.6] mm/h; P = .02; CRP level, 1.5 mg/L; 25%-75%, 0.75-1.18 mg/L; P = .03).

Bile juice spillage was significantly observed in patients with difficulties in obtaining the safety view (odds ratio [OR], 3.182; 95% confidence interval [CI], 1.012-10.006; P = .048). However, difficulties in visualization of the Calot triangle did not affect the rate of complications (OR, 1.777; 95% CI, 0.356-8.748; P = .57) or the rate of conversion to conventional laparoscopic cholecystectomy (2.600; 0.657-10.285; P = .17). Moreover, bile juice spillage showed no significant difference for the prevalence rate of surgical site infection (OR, 1.012; 95% CI, 0.357-21.187; P = .33).

COMPARISON BETWEEN THE NO-CONVERSION AND CONVERSION GROUPS

The mean (SD) age of patients who underwent conversion surgery (56.4 [9.0] years) was significantly higher than that of the no-conversion group (45.1 [13.3] years, P = .01). The mean (SD) BMI was slightly higher in the conversion group (25.8 [2.4] vs 23.5 [3.1]), and the difference was significant (P = .03). The conversion rates were different according to the operators, yet there was no significance for this factor (P > .05). The mean (SD) operation time in the conversion group (95.7 [26.6] minutes) was longer than that in the no-conversion group (91.2 [32.0] minutes), but the difference was not significant (P = .68). The mean (SD) duration of the postoperative hospital stay showed no difference between the no-conversion and conversion groups (2.3 [1.8] vs 2.4 [1.2] days), and the mean (SD) values of the preoperative inflammatory markers, including white blood cell count (6227 [1866] vs 6530 [1605] /μL), ESR (24.6 vs 27.8 mm/h), and mean CRP levels (4.5 vs 9.8 mg/L), were not different between the 2 groups.

Increased age was correlated with an increased rate of conversion during single-incision multiport laparoscopic surgery (OR, 1.081; 95% CI, 1.013-1.155; P = .02). The more the BMI increased, the more the rate of conversion increased (OR, 1.348; 95% CI, 1.022-1.777; P = .03). However, there was no significant difference in the rate of conversion according to sex, levels of preoperative inflammatory markers, operation time, and operator. On multivariate analysis, only BMI showed a significant difference for the rate of conversion to conventional laparoscopic cholecystectomy (OR, 1.426; 95% CI, 1.003-2.027; P = .048).

COMMENT

In this study, we performed single-incision multiport laparoscopic cholecystectomy in 64 patients with symptomatic gallstones and gallbladder polyps, and we excluded patients with acute cholecystitis, previous upper abdominal surgery, choleodocholithiasis, and a suspicion of malignancy. We demonstrated that a higher BMI could be the risk factor for conversion when performing single-incision multiport laparoscopic cholecystectomy. Considering that the early experiences with laparoscopic cholecystectomy were associated with higher rates of bile duct injuries, we conclude that performing single-incision multiport laparoscopic cholecystectomy with conventional laparoscopic instruments is safe and feasible, especially in well-selected patients, for experienced surgeons with a low threshold for conversion to conventional laparoscopic cholecystectomy.

In this study, there were 2 bile duct injuries. The most common complication in clinical studies of single-
incision multiport laparoscopic cholecystectomy has been bile duct injury. Other complications were liver injury, abdominal wall hematoma, surgical site infection, mesenteric injury, pain, and urinary incontinence. Of those complications, bile duct injury is a devastating complication that has been shown to be associated with significant perioperative morbidity and mortality and shortened long-term survival. Laparoscopic bile duct injuries originate principally from visual perceptual illusion and not from errors in skill, knowledge, and judgment. The most difficult and challenging task in performing single-incision multiport laparoscopic cholecystectomy is to get the critical view because of the limited angle and number of instruments. The use of laparoscopic instruments, when used through a single incision with a multitport, often results in inadequate retraction, loss of triangulation, unintended movement, and hands or trocars fighting for space, which all lead to a prolonged operation time, inadequate exposure of the Calot triangle, and development of complications. Therefore, a low threshold for conversion to conventional laparoscopic cholecystectomy or additional methods for obtaining the safety view are required when there are difficulties in visualizing the Calot triangle when performing single-incision multiport laparoscopic cholecystectomy.

Efforts to obtain the critical view of safety can be divided into 2 groups based on the clinical trials. Some research groups, including the present study, selected the patients according to their own exclusion criteria, and other groups used additional percutaneous punctures of the gallbladder to guarantee the critical view. In previous studies, the most common exclusion was acute cholecystitis, and other minor exclusions were previous upper abdominal surgery, a suspicion of malignancy, a high BMI, and gallstone pancreatitis. A few studies have reported surgical success in the setting of acute cholecystitis or obese patients with use of an additional traction device. Percutaneous suture, a suspension hook for gallbladder retraction, or a smaller size of trocar or instrument can serve to obtain better visualization for dissection. Such maneuvers may cause spillage of bile juice and may lead to an increased chance of wound contamination and then increase the risk of surgical site infection, particularly in the setting of acute cholecystitis.

In the present study, there were 4 surgical site infections, yet all the patients improved without complications or a prolonged hospital stay. Although the bile juice spillage was not correlated with the occurrence of complications in this study, bile juice spillage occurred in 3 patients with surgical site infections. Considering the high rates of gallbladder perforation in single-incision multiport laparoscopic surgery, there have been few successful studies without percutaneous suture and exclusion criteria, and more careful gallbladder dissection and percutaneous sutures in selected patients can help in the development of single-incision multiport laparoscopic surgery and improve the outcomes. Because wound contamination might be the most likely cause of surgical site infection rather than gallbladder perforation or bile juice spillage, meticulous management of the surgical site is probably required for cosmesis, which is the only known benefit of single-incision multiport laparoscopic surgery.

Beyond the known benefits to cosmesis and pain management, it is necessary to evaluate the safety, efficacy, complication rates, immunologic response, and potential benefits, if any, that single-incision multiport laparoscopic surgery may provide. Before patients demand this minimally invasive surgery in the same way that forced the explosion of laparoscopic surgery 20 years ago, we expect that randomized prospective studies will provide the pros and cons of single-incision multiport laparoscopic surgery.

In conclusion, single-incision multiport laparoscopic cholecystectomy is an emerging operative method that can obtain a scarless abdomen. Experienced laparoscopic surgeons can safely perform this operation using conventional and curved laparoscopic instruments. We recommend consideration of conventional laparoscopic cholecystectomy or use of additional retraction devices for patients with a higher BMI or acute cholecystitis in difficult situations for obtaining the critical safe view.

We are unsure whether this operation will become a bridge to natural orifice transluminal endoscopic surgery or whether it will open up a new field of minimally invasive surgery. Yet, keeping an open mind for conversion to conventional laparoscopic cholecystectomy and assigning priority to the safety of patients over cosmesis will help avoid serious complications when surgeons encounter difficulties during this type of operation.

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scopic surgery and the magnification afforded by these technologies existed between the reduced access inherent in laparoscopic cholecystectomy and the magnification afforded by operating through too small an incision placed parallel to the side to side and not end to end, we have been taught, and of the operative field was essential. Wounds heal from the surface (and remains) that adequate exposure and visualization of the operative field was essential. Wounds heal from the surface and from the sides of the incision, allowing the surgeon to see the biliary anatomy. Lack of imagination and reluctance to consider change kept the Germans from embracing new instruments that greatly improved a surgeon’s ability to see the biliary anatomy. Lack of imagination and unwillingness to consider change kept the Germans from claiming credit for one of the most important transformative changes in the history of surgery.

How laparoscopic cholecystectomy changed surgery is a well-known story. The Germans were not alone in resisting this new technique. Most recognized experts in biliary surgery in the 1990s opposed this new approach to gallbladder removal, fearing that limited exposure to the operative field would cause an unacceptable increase in bile duct injury. The naysayers were taken by surprise by unexpected developments. Initial series of laparoscopic cholecystectomy reported 10-fold higher bile duct injury rates than were the norm. Increases in bile duct injury rates from 0.1% to 1.0% meant little to patients. Bile duct injury was an abstraction to patients then because they were, on average, unfamiliar with the complication and its ramifications, and, even at a higher rate, it was a relatively rare complication. Laparoscopic surgery facilitated enhanced, not reduced, visualization resulting from the substantial magnification inherent to laparoscopic instruments. In fact, once surgeons became more experienced with these new technologies, complication rates dramatically fell.

Patients were far more concerned about painful incisions than potential complications. Despite surgeons’ insistence that wounds were important only in their side-