



Laparoscopic Cholecystectomy: Experience of a Single Surgeon

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Gallbladder removal using laparoscopic techniques has rapidly been adopted by surgeons around the world. Questions have been raised concerning laparoscopic cholecystectomy, including the safety of the operation, its implications for management of common bile duct stones, and the means by which surgeons should be trained. In the present series, 424 patients were referred to a single surgeon for cholecystectomy during a 22-month period. A traditional open cholecystectomy was performed in 9 patients (2.1%) because of presumed contraindications to laparoscopic cholecystectomy. Laparoscopic cholecystectomy was attempted in the remaining 415 patients (97.9%). On the basis of preoperative investigations, 19 patients (4.6%) underwent endoscopic retrograde cholangiopancreatography. Endoscopic sphincterotomy and stone extraction were performed in the 13 patients (3.1%) demonstrating choledocholithiasis. Laparoscopic cholecystectomy was converted to an open operation in 8 patients (1.9%) owing to dense adhesions, obscure anatomy, or cholangiographic abnormalities. Laparoscopic cholecystectomy was successfully performed in 407 patients (96%) in 95 ± 2 minutes (mean \pm SEM). Surgical trainees were involved in all operations and performed 68% of the procedures under supervision. Cystic duct cholangiograms were obtained selectively in 129 patients (30.4%). Intraoperative complications occurred in 3 patients, including 1 patient with a minor injury to the common bile duct (0.2%). There was no perioperative mortality, and major complications occurred in 6 patients (1.4%). Minor complications were seen in 12 others (2.8%), and one patient required reoperation for a trocar injury to the jejunum. Prolonged follow-up has revealed one case of asymptomatic retained common bile duct stones (0.2%). Laparoscopic cholecystectomy can therefore be performed in more than 95% of patients with no mortality and minimal morbidity. The operation is safely taught to surgical trainees. Choledocholithiasis may be treated by a combination of endoscopic and laparoscopic techniques. Because of these considerations, laparoscopic cholecystectomy has become the preferred therapy for symptomatic cholelithiasis at our institution.

Since its introduction in 1987, gallbladder removal using laparoscopic guidance and instrumentation has been adopted by surgeons at an unprecedented rate. In contrast to the traditional "open" cholecystectomy, laparoscopic cholecystectomy reduces postoperative pain and results in shortened hospitalization and less disability [1]. Video-laparoscopy, however, is currently associated with two-dimensional visualization of the operative field [2] and limited tactile feedback; and early results suggest that there is a steep learning curve for laparoscopic

cholecystectomy associated with an increased risk of injury to the common bile duct [3].

To date, published reports of laparoscopic cholecystectomy either have described small numbers of patients [4–6], or have been the compiled results of many surgeons using varied techniques [3, 7–9]. The current report summarizes our experience with 424 consecutive patients treated by cholecystectomy at a teaching institution. The data were accrued prospectively by a single surgeon using a standard approach to patient management.

Patients and Methods

Methods

After demonstrating the feasibility and safety of laparoscopic cholecystectomy using monopolar electrocautery in the porcine model [10], approval was granted by the Human Studies Committee of our institution to initiate clinical application of laparoscopic cholecystectomy in November 1989. All patients were assessed preoperatively with ultrasonography of the right upper quadrant and measurement of serum liver enzymes (bilirubin, transaminases, alkaline phosphatase). Additional examinations were performed when indicated clinically, including hepatobiliary scintigraphy, computed tomography, upper gastrointestinal endoscopy, and endoscopic retrograde cholangiopancreatography (ERCP). Preoperative ERCP was performed in patients deemed likely to have concomitant choledocholithiasis, including those with elevated serum bilirubin and alkaline phosphatase, a dilated common bile duct as seen by ultrasonography (>10 mm), those with sonographic demonstration of stones in the bile duct, and patients with unremitting acute biliary pancreatitis.

Most patients were admitted to the hospital on the morning of operation, outfitted with intermittent graded pneumatic compression stockings, and administered a preoperative dose of intravenous antibiotics. After induction of general anesthesia, a Foley catheter and orogastric tube were placed. A standard "four-puncture" laparoscopic cholecystectomy was performed using monopolar electrocautery for dissection and hemostasis [4–6, 8–11]. Surgical trainees were involved in all operations, as

Table 1. Surgical procedures in 424 patients.

Operation	No.	%
Open cholecystectomy	9	2.1
Attempted laparoscopic cholecystectomy	415	97.9
Males/females	103/312	25/75
Acute cholecystitis	23	6
Asymptomatic cholelithiasis	2	0.5
Acalculous cholecystitis	5	1.2
Preoperative ERCP/stone extraction	19/13	4.6/3.1

either the first assistant or the operating surgeon under direct supervision. The pneumoperitoneum was induced in most patients using a Veress needle in "closed" fashion, but "open" insertion of the initial umbilical trocar (11 mm) with direct visualization of the abdominal contents was performed in the presence of periumbilical scars and in those with large (> 2.5 cm) gallstones. After placing the video-laparoscope through the umbilical port, all other manipulations were performed under direct video guidance. Accessory trocars (5 mm) were placed in the right anterior axillary and midclavicular lines, and a larger operating port (10–11 mm) was placed in the subxiphoid midline. The cystic duct and artery were isolated from the surrounding tissues using blunt dissection, carefully displaying these structures from both their ventral (classic Calot's triangle) and dorsal ("reverse" Calot's triangle) aspects. Cystic duct cholangiograms were obtained selectively. The cystic duct and artery were doubly ligated with titanium clips or suture and then divided. The gallbladder was excised from the hepatic fossa in a retrograde fashion (from the infundibulum to the fundus) using a monopolar cautery probe. The gallbladder was then extracted from the abdomen through the umbilical incision. The fascia of the umbilical incision was closed with an absorbable suture and the skin with subcuticular absorbable sutures. After uncomplicated laparoscopic cholecystectomy the patients were admitted for observation overnight and were allowed an immediate postoperative diet.

Patients

Between November 1989 and August 1991 a total of 424 patients were referred for cholecystectomy (Table 1). During initial application of the technique, some patients underwent traditional open cholecystectomy because of presumed contraindications to laparoscopic cholecystectomy. Laparoscopic cholecystectomy was therefore denied to 9 patients (2.1%) for multiple reasons, including choledocholithiasis with a previously failed ERCP, acute cholecystitis with a palpable mass, morbid obesity, or multiple previous upper abdominal operations.

The remaining 415 patients (97.9%) underwent attempted laparoscopic cholecystectomy. In this group, 103 were men (25%) and 312 (75%) were women. The patients' ages ranged from 18 to 84 years (mean \pm SEM, 48 ± 1 years), and they weighed 39 to 148 kg (77 ± 1 kg). The indication for surgery in 408 patients (98.3%) was symptomatic cholelithiasis. Of this group, 23 had acute cholecystitis (6%), 10 patients had acute

Table 2. Operative results.

Operation	No.	%
Attempted laparoscopic cholecystectomy	415	
Converted to open cholecystectomy	8	1.9
Adhesions/inflammation	6	
Common bile duct stone	1	
Common bile duct injury	1	
Successful laparoscopic cholecystectomy	407	98.1
Operative time	95 ± 2 min ^a	
"Open" insertion of initial port	112	28
"Closed" insertion of initial port	295	72
Cholangiography attempted/successful	138/129	34/32
Intraoperative complications (CBD laceration, urethral injury, jejunal perforation)	3	0.7

^aMean \pm SEM.

biliary pancreatitis, and 2 patients were in the second trimester of pregnancy. Two immunocompromised patients were operated for asymptomatic cholelithiasis. Five patients underwent operation for acalculous cholecystitis with reduced gallbladder ejection fraction on hepatobiliary scintigraphy. On the basis of preoperative investigations, 19 patients (4.6%) were suspected of having common bile duct stones and underwent ERCP. Ductal calculi were demonstrated in 13 patients (3.2%), and endoscopic sphincterotomy with stone extraction was performed prior to laparoscopic cholecystectomy.

Results

Conversion to open cholecystectomy was required in 8 patients (1.9%) because of dense adhesions, obscure anatomy, or cholangiographic abnormalities (Table 2). This group included the only patient (249th in the series) in whom a common bile duct injury occurred (0.2%). In this patient the cholangiocatheter was inserted mistakenly into the common bile duct just distal to the insertion of the cystic duct, with the result that cholangiograms demonstrated flow of contrast in the distal duct only. Laparotomy was performed with insertion of a T-tube into the laceration; a short stricture was subsequently treated by postoperative balloon dilatation and stenting, and the patient recovered without other sequelae. The other patients who were converted to an open cholecystectomy had uneventful postoperative courses.

The remaining 407 patients (96%) were successfully treated by laparoscopic cholecystectomy. Surgical trainees performed 277 (68%) of the operations under supervision, including 45% of the first 100 cases and 79% of the last 100 cases. The duration of the laparoscopic operation ranged from 35 to 250 minutes (95 ± 2 minutes). The laparoscope was inserted by the "open" technique in 112 cases (28%) and by the "closed" method in 295 patients (72%). Cystic duct cholangiography was attempted in 138 patients (34%), of which 129 (93%) were successful. Intraoperative complications of laparoscopic cholecystectomy occurred in three patients (0.7%). In addition to the common bile duct injury, in one patient the Foley catheter was inadvertently inflated in the urethra, requiring intraoperative cystoscopy and postoperative urinary drainage, and one patient suffered an unrecognized trocar injury to the small bowel, leading to

Table 3. Postoperative results.

Result	No.	%
Perioperative mortality	0	
Hospital stay (postoperative)	1.1 ± 0.1 days ^a	
Major complications	6	1.5
Minor complications	12	2.9
Return to work	8.5 ± 0.3 days ^a	
Retained bile duct stones	1	0.2

^aMean ± SEM.

reexploration and jejunal resection/anastomosis on the second postoperative day.

Filling defects were demonstrated in the common bile duct in 3 patients (0.7%). In one case, a large, totally obstructing common bile duct stone was treated by conversion to an open procedure with standard common bile duct exploration. In a second patient a round 2-mm filling defect contained within a nondilated common bile duct was allowed to remain in place. The patient has remained asymptomatic with a normal bile duct on postoperative ultrasonography; we suspect the cholangiographic filling defect may have been an air bubble. In the third patient, a single 4-mm common bile duct stone was extracted using a basket introduced through a ureteroscope passed via the cystic duct into the common bile duct [12].

No deaths have occurred during the perioperative period (Table 3). The 407 patients treated by laparoscopic cholecystectomy remained in the hospital for 1 to 9 days postoperatively (1.1 ± 0.1 days). During the postoperative period, only 19 patients (5%) required parenteral narcotic analgesics, with a mean total morphine dosage of 2.7 ± 0.3 mg. Early postoperative complications occurred in six patients (1.4%). One patient suffered a nonfatal acute myocardial infarction 24 hours after his discharge on the first postoperative day. One patient developed intraoperative ventricular tachycardia requiring pharmacologic therapy and resulting in an extensive (negative) postoperative cardiac investigation. Only two patients (0.5%) developed significant postoperative atelectasis. One patient developed an incarcerated right inguinal hernia on the sixth postoperative day requiring urgent repair. Finally, one patient developed abdominal pain and incisional cellulitis that required hospitalization and intravenous antibiotics.

During the early postoperative period, patients undergoing successful laparoscopic cholecystectomy returned to work (or to full activity if unemployed or retired) at 8.5 ± 0.3 days. Five patients (1.2%) developed abdominal pain during the first postoperative month, resulting in hospitalization for diagnostic evaluation; in all instances, there was no evidence of a procedure-related complication. Superficial wound infections were seen in four other patients (0.9%). Thus major complications occurred in 6 patients (1.5%) and minor complications in 12 patients (2.9%).

Long-term outcome (1–22 months) of patients treated by laparoscopic cholecystectomy has revealed one case of retained common bile duct stones (0.2%). This patient was found to have asymptomatic choledocholithiasis demonstrated incidentally during performance of a right upper quadrant ultrasound scan obtained because of the investigational protocol. In this indi-

vidual, serum liver enzymes were normal and the bile duct was 6 mm in diameter; it had been elected to treat these common bile duct stones expectantly. Recurrent abdominal pain postoperatively has resulted in diagnostic ERCP in 5 patients (1.2%). In 3 patients, the endoscopic examinations have been completely normal, 1 patient had evidence of a gastric ulcer, and 1 patient had mild narrowing of the sphincter of Oddi.

Discussion

Since it was first performed in 1987 by Mouret in France [13] and initially reported in 1988 by Reddick in the United States [14], laparoscopic cholecystectomy has rapidly been adopted by surgeons around the world, becoming the primary modality for gallbladder removal in many centers. At our hospital, laparoscopic cholecystectomy evolved over a period of 22 months from an investigational procedure to the means by which more than 90% of gallbladders are removed. The advantages of laparoscopic cholecystectomy are demonstrated by the minimal requirement for postoperative analgesia, the brief duration of postoperative hospitalization and disability [1], and a reduction in the expected incidence of perioperative morbidity usually reported after standard open cholecystectomy [15]. There are also a number of disadvantages of laparoscopic cholecystectomy compared to open cholecystectomy. The video-laparoscopic image, directed by an assistant, is monocular, resulting in a lack of three-dimensional depth perception [2, 16]. The laparoscopic procedure also takes longer to perform than the open operation [1], and there is a learning curve during which injuries to the common bile duct are more likely to occur [3]. With patience, meticulous technique, and the magnification afforded by the laparoscopic view, it is our belief that laparoscopic cholecystectomy should ultimately prove to be as safe as or safer than its open counterpart.

In our study laparoscopic cholecystectomy was possible in more than 95% of patients, including selected patients with acute cholecystitis. Major complications were infrequent (1.5%), and we have had only one minor common bile duct injury, which did not require a biliary reconstruction. One patient required reoperation for a small bowel injury caused by the umbilical trocar. The average postoperative hospital stay of 1 day and the brief duration of disability should ultimately lead to this procedure being less costly to society than open cholecystectomy [4, 6].

Our results compare favorably to those of other published series to date (Table 4). In most series, conversion to open cholecystectomy is required in fewer than 10% of patients, but selection bias plays a role in the frequency of this occurrence. Perioperative mortality is uncommon after laparoscopic cholecystectomy, and major complications have been reported in fewer than 5% of all patients. The incidence of bile duct injuries in some series is slightly higher than the established rate of 0.1% to 0.4% for open cholecystectomy [15, 17], but the frequency of bile duct injury may relate directly to the experience of the operating surgeon [3]. If so, we would expect the incidence of bile duct injury associated with laparoscopic cholecystectomy to decrease over the succeeding years.

Although removal of the gallbladder using laparoscopic guidance has become a well established technique, a number of controversial areas remain. We have used monopolar electro-

Table 4. Compiled results of laparoscopic cholecystectomy.

Series	No. of pts.	% Converted ^a	% Mortality	% Major complications	% Bile duct injury
Authors' personal series	415	1.9	0	1.5	0.2
Spaw et al. [8]	500	1.8	0	1.0	0
Southern surgeons [3]	1518	4.7	0.07	1.5	0.5
European surgeons [7]	1236	3.6	0	1.6	0.3
Graves et al. [9]	304	6.9	0	0.7	0.3
Schirmer et al. [6]	152	8.5	0	4.0	0.7
Zucker et al. [5]	100	5	0	2.0	1.0
Peters et al. [4]	100	4	0	4.0	1.0

^aConverted to open laparotomy.

cautery as the thermal source for hemostasis and excision of the gallbladder bed from its fossa, as we believe electrocautery is easier to use and less expensive than laser [18], although various wavelengths of laser energy may be used in an equally safe fashion [3, 7, 8, 14]. As with traditional open cholecystectomy, intraoperative cholangiography can be performed during laparoscopic cholecystectomy routinely or on a selective basis. We have chosen to perform cholangiography on a selective basis, believing the procedure to be time-consuming and expensive [18, 19]. Surgeons must be able to perform cholangiography when indicated, however, particularly when the biliary anatomy is unclear. Using this selective approach, we have obtained cholangiograms in approximately 30% of patients, with only one bile duct injury and one known retained bile duct stone.

The management of choledocholithiasis found in association with cholecystolithiasis is also controversial. We have elected to perform preoperative endoscopic cholangiography with stone removal in patients with a high likelihood of choledocholithiasis [20]. We were able to extract one common bile duct stone through the cystic duct using a ureteroscope during the laparoscopic operation [12], and many surgeons are working on means by which the common bile duct may be accessed on a routine basis with laparoscopic techniques. Using the combination of endoscopy and laparoscopy, common bile duct stones have been demonstrated in only 16 patients (3.8%), an incidence lower than that reported in many published reports of cholecystectomy [15, 17, 19]. This difference may be a phenomenon of the referral basis at our institution.

Laparoscopic cholecystectomy has become established as a safe and effective technique for management of gallbladder disease. The role of endoscopic sphincterotomy, stone extraction, and intraoperative laparoscopic techniques for management of choledocholithiasis can be determined only with long-term studies. Perhaps more important than the effective removal of gallbladders, utilization of laparoscopic techniques may ultimately revolutionize the practice of intraabdominal surgery on a more widespread basis. Certainly, laparoscopic cholecystectomy has revolutionized the care of patients with uncomplicated gallstone disease and has become the new "gold standard" [21] for treatment of this disease at our institution.

Résumé

L'ablation de la vésicule biliaire par des techniques coelioscopiques a été rapidement adoptée par les chirurgiens dans le

monde entier. On s'interroge cependant sur: a) la sûreté de l'intervention, b) l'attitude à envisager en cas de lithiase de la voie biliaire principale et c) la meilleure façon d'enseigner cette technique aux autres chirurgiens. La série présentée ici comporte 424 patients consécutifs opérés par un seul chirurgien pendant une période de 22 mois. Une cholécystectomie traditionnelle a été réalisée d'emblée dans 9 cas (2.1%) car la cholécystectomie sous coelioscopie avait été jugée contre-indiquée. Une cholécystectomie a été envisagée sous coelioscopie chez les 415 patients restants (97.9%). Selon les données préopératoires, une cholangiopancreatographie rétrograde par voie endoscopique a été réalisée chez 19 patients (4.6%). Une sphinctérotomie endoscopique avec extraction des calculs a été réalisée chez les 13 patients (3.1%) chez lesquels une lithiase de la voie biliaire principale avait été mise en évidence. Une conversion en cholécystectomie traditionnelle a été nécessaire chez 8 patients (1.9%) en raison d'adhérences serrées, de difficultés pour reconnaître l'anatomie locale ou devant des anomalies cholangiographiques. La cholécystectomie coelioscopique a été réalisée avec succès chez 407 patients (98.9%) en 95 minutes (moyenne \pm erreur standardisée). Des chirurgiens en formation ont participé à toutes les interventions et, sous surveillance, en ont réalisée 68%. Une cholangiographie a été réalisée de façon sélective chez 129 patients (32%). Une complication peropératoire a été notée chez 3 patients, y compris une lésion de la voie biliaire principale (0.2%). Il n'y avait aucune mortalité alors qu'on a enregistré 6 complications (1.4%) dans la période périopératoire. Des complications mineures ont été observées chez 12 autres patients (2.9%) et un patient a eu besoin d'être réopéré en raison d'une lésion jéjunale provoquée par un trocard. Le suivi a permis de mettre en évidence un seul cas de lithiase résiduelle de la voie biliaire principale, asymptomatique (0.2%). La cholécystectomie coelioscopique peut donc être réalisée chez plus de 95% des patients sans mortalité et avec une morbidité minime. L'intervention peut être enseignée avec sécurité. La lithiase de la voie biliaire principale peut être traitée par une combinaison de techniques endoscopiques et coelioscopiques. Au vu de ces conclusions, la cholécystectomie sous coelioscopie est devenue la thérapeutique de choix pour la lithiase biliaire symptomatique dans notre service.

Resumen

La remoción de la vesícula biliar mediante técnicas laparoscópicas ha sido rápidamente adoptada por los cirujanos del mundo

entero. Se han planteado interrogantes sobre la colecistectomía laparoscópica, incluyendo la seguridad de la operación, sus implicaciones en cuanto al manejo de cálculos capacitados. En la serie que aquí se presenta, 424 pacientes fueron referidos para colecistectomía a un mismo cirujano en un periodo de 22 meses. Se practicó colecistectomía abierta tradicional en 9 pacientes (2.1%) debido a presumibles contraindicaciones de la colecistectomía laparoscópica. Se intento realizar colecistectomía laparoscópica en los 415 pacientes restantes (97.9%). Con base en la valoración preoperatoria, 19 pacientes (4.6%) fueron sometidos a colangiopancreatografía retrógrada, y se practicó esfinterotomía endoscópica con extracción de cálculos en los 13 (3.1%) en que se demostró coledolitiasis. La colecistectomía laparoscópica fue convertida a operación abierta en 8 (1.9%) debido a adherencias densas, anatomía no esclarecida o anomalías colangiográficas. La colecistectomía laparoscópica fue completada exitosamente en 407 pacientes (98.9%) en un tiempo de 95 ± 2 min (promedio \pm DEM). Los cirujanos en adiestramiento estuvieron involucrados en la totalidad de las operaciones y realizar el 68% de los procedimientos bajo supervisión. Se realizaron colangiogramas por vía del canal cístico en forma selectiva en 129 pacientes (31%). Complicaciones intraoperatorias fueron registradas en 3 pacientes, incluyendo uno que sufrió mínima lesión del colédoco (0.2%). No hubo mortalidad perioperatoria y se presentaron complicaciones mayores en 6 pacientes (1.4%). Complicaciones menores fueron observadas en 12 casos (2.9%) y un paciente tuvo que ser reoperado por una lesión del yeyuno causada por trócar. El seguimiento postoperatorio ha revelado un caso de cálculos retenidos en el colédoco (0.2%). Nuestra conclusión es que la colecistectomía laparoscópica puede ser realizada en más del 95% de los pacientes sin mortalidad y con mínima morbilidad; la operación puede ser enseñada en forma segura a cirujanos en adiestramiento. La coledolitiasis puede ser tratada mediante la combinación de técnicas endoscópicas y laparoscópicas. Por razón de tales consideraciones, la colecistectomía laparoscópica se ha convertido en la modalidad terapéutica de preferencia para coledolitiasis sintomática en nuestra institución.

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Update

My personal series now consists of 617 patients who have undergone attempted laparoscopic cholecystectomy, 15 (2.4%) of which cases have been converted to an open operation. In this group are the first two patients discovered to have gallbladder carcinoma. In both cases the tumor was unresectable, and the patients subsequently died. No additional common bile duct injuries have occurred, for an incidence of 1/617 (0.16%). Preoperative ERCP has been performed in 32 patients, of whom 17 (53%) have undergone endoscopic sphincterotomy with stone extraction. Postoperative ERCP has been performed in 12 patients, with 4 patients having common bile duct stones removed, including the patient mentioned in the main body of this paper who subsequently developed symptoms from her known cholelithiasis at 18 months after laparoscopic cholecystectomy. Laparoscopic transcystic duct common bile duct stone removal has been successful in 5 of the 6 patients in whom it was attempted.

For three reasons I have changed my approach from *selective* intraoperative cholangiography to *routine* intraoperative cholangiography: (1) to train surgical residents so they may become adept at performing cholangiography; (2) because a fluoroscopic unit has become available that decreases the time and "frustration factor" of cholangiography; and (3) because establishing routine access to the cystic duct with fluoroscopic guidance facilitates development of the skills necessary for laparoscopic management of common bile duct stones.