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Gallstones and laparoscopic cholecystectomy

NIH Consensus Development Panel on Gallstones and Laparoscopic Cholecystectomy

Approximately 10% to 15% of the adult population or more than 20 million people in the United States have gallstones. It is estimated that there are about 1 million newly diagnosed patients annually. The prevalence is higher in women, in association with multiple pregnancies, obesity, and rapid weight loss, as well as in older patients and in certain ethnic groups. In 1991, approximately 600,000 patients underwent cholecystectomy. As a cause of hospitalization, gallstones are the most common and most costly digestive disease, with an annual estimated overall cost of more than $5 billion.

In humans, gallstones are composed principally of cholesterol, with pigment stones occurring less commonly. The formation of cholesterol stones is believed to result from the occurrence of cholesterol supersaturation, accelerated cholesterol crystal nucleation, and impaired gallbladder motility. Stones tend to grow for the first 2 to 3 years, at which point growth tends to stabilize; 85% of all gallstones are less than 2 cm in diameter. Most patients with gallstones remain asymptomatic for many years and may, in fact, never develop symptoms. However, the consequences of gallstones may be severe, ranging from brief episodes of biliary pain (misnamed "colic") to potentially life-threatening complications, such as acute cholecystitis and pancreatitis or rarely gallbladder cancer.

Until 2 years ago, the prevailing treatment of symptomatic gallstones was an open operation through an abdominal incision to remove the gallbladder. The usual course of recovery from this procedure was a 5-day hospital stay and a 3- to 6-week period of convalescence. Although the mortality of the operation was relatively low (about 0.05%, except in older or high-risk individuals), a variety of nonsurgical approaches were developed and used in selected patient populations. These alternative approaches include oral bile acid dissolution therapy, contact solvent dissolution or mechanical extraction through a catheter placed into the gallbladder (either percutaneously or endoscopically), and fragmentation by shock wave lithotripsy combined with bile acid dissolution therapy. All such alternative approaches leave the gallbladder intact, and thus eventual stone recurrence in a significant number of cases is a potential drawback.

Laparoscopic cholecystectomy is a new operation that was first performed in France in 1987 and in the United States in 1988. It is performed using laparoscopic visualization of the gallbladder and surrounding vital structures. After distention of the abdominal cavity with carbon dioxide gas, the laparoscopic imaging and surgical instruments are introduced through multiple (about 1.2 cm) incisions for visualization, manipulation, and dissection. The operation is viewed on a video screen with magnification. The operative steps, which include identification, isolation, and division of the cystic duct and artery, with subsequent removal of the gallbladder from its attachment to the liver, require meticulous surgical technique. Once free, the gallbladder is pulled through one of the small incisions to the exterior, the laparoscope and instruments are removed, and the incisions are closed with sutures and covered with small bandages. The operation usually requires general anesthesia and is subject to the same risks and complications as open cholecystectomy. However, patients have little pain after the operation, and hospital stay (1 to 2 days) and convalescence (1 to 2 weeks) are usually shorter than after open cholecystectomy.

It is estimated that more than 15,000 surgeons have received some training in the technique of laparoscopic cholecystectomy, and demand for this form of surgery has escalated to the point where probably about 80% of cholecystectomies are being performed in this manner. Ongoing attempts are being made to evaluate the safety and efficacy of this procedure, but it is doubtful that a large randomized trial to compare it with open cholecystectomy will be performed. Based on currently available data, complications of laparoscopic cholecystectomy occur infrequently, although evidence indicates that the incidence of bile duct injuries is increased compared with open cholecystectomy.

To evaluate the available data on laparoscopic cholecystectomy, including evolving techniques, patient selection, and data on traditional surgical and medical

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treatments for gallstone disease, the Office of Medical Applications of Research and the National Institute of Diabetes and Digestive and Kidney Diseases of the National Institutes of Health, Bethesda, Md, convened a consensus development conference on September 14–16, 1992. The specific problems and patient issues that must be evaluated in dealing with this disease were addressed by surgeons, endoscopists, hepatologists, gastroenterologists, radiologists, epidemiologists, and representatives of the general public. After 2 days of presentations by medical experts and discussion from the audience, an independent consensus panel weighed the available scientific evidence and formulated this consensus statement that addressed the questions that follow.

Which patients with gallstones should be treated?

Gallstones present in one of three clinical stages: (1) asymptomatic, (2) symptomatic, and (3) with complications. Gallstone complications, which include acute cholecystitis, common bile duct stones with or without cholangitis or pancreatitis, gallstone ileus, and gallbladder cancer, are all potentially life threatening and almost always merit prompt treatment. The issue is which asymptomatic individuals and which patients with symptoms, but without complications, should be treated.

Asymptomatic gallstone

The majority of gallstones remain silent throughout life. Only 1% to 4% per year of asymptomatic patients will develop symptoms or a complication of gallstone disease. Existing data indicate that 10% of patients will develop symptoms in the first 5 years after diagnosis and approximately 20% by 20 years. Almost all patients will experience symptoms for a period of time before they develop a complication. Therefore, with few exceptions prophylactic treatment of asymptomatic patients cannot be justified. This also applies to diabetic patients with asymptomatic gallstones. However, because of higher morbidity and mortality rates after emergency operations in diabetic patients, they should be treated promptly when symptoms first appear. It remains controversial whether incidental cholecystectomy during nonbiliary abdominal surgery in asymptomatic individuals is beneficial. It is clear, however, that incidental cholecystectomy should not be done in certain patients at high risk for complications, such as those with cirrhosis and portal hypertension. Insufficient data are present to determine whether prophylactic treatment is indicated in certain other groups with asymptomatic gallstones, such as patients with sickle cell disease and children, both of whom may present diagnostic dilemmas, pretransplantation and/or immunosuppressed patients who may have markedly increased morbidity and mortality from gallstone complications, and those who are isolated from medical care for long intervals. Although oral bile acid therapy has been shown to be effective in the prevention of gallstone formation in certain highly susceptible individuals (e.g., those undergoing rapid weight reduction), the advisability of such treatment has not been established.

The risk of gallbladder cancer in patients with gallstones is so low (one per 1000 patients per year) that it is not a reasonable justification for prophylactic treatment. One clear exception is the rare entity of the calcified (porcelain) gallbladder, which even in the absence of stones should be removed because of its frequent (about 25%) association with gallbladder cancer. Less clear exceptions are some North and South American Indians, individuals with solitary gallbladder polyps more than 1 cm in diameter, individuals with anomalous pancreaticobiliary ductal junctions, and individuals with gallstones more than 3 cm in diameter. The risk of gallbladder cancer in all of these groups has been reported to be substantially higher than in other patients with gallstones.

Once gallstone symptoms appear, they recur in the majority of patients. Furthermore, patients with symptoms secondary to gallstones are more likely (25% within 10 to 20 years) than asymptomatic patients to develop complications. Thus, most symptomatic patients should be treated. The challenge to the clinician is ascertaining which symptoms are and which are not due to gallstones. The best definition of biliary pain is that which is relatively severe, episodic, epigastric or right upper quadrant in location, lasting 1 to 5 hours, and often waking the patient at night. They are the symptoms that warrant therapy. Although biliary pain also may occur postprandially, this is not a discriminating symptom from other common abdominal conditions (e.g., irritable bowel syndrome). Nearly 90% of patients with typical biliary pain are rendered symptom free after successful treatment of their gallstones. Those who are too ill to undergo general anesthesia should be managed with nonoperative therapies. The results of treatment of patients with gallstones are less successful in individuals with atypical pain patterns or painless dyspepsia (fatty food intolerance, bloating, and belching). Such patients should undergo further diagnostic testing to determine whether other diseases, such as irritable bowel syndrome, peptic ulcer disease, or gastroesophageal reflux may be the cause of these symptoms.

There is a small group of patients without gallstones and no other identifiable abnormality of the gallbladder who have typical biliary pain. Although pain may be relieved after removal of the gallbladder in some of these patients, it is not in others. Thus, the efficacy of operative therapy in this setting has not been established.

Which patients with gallstones should be treated with laparoscopic cholecystectomy?

Most patients with symptomatic gallstones are candidates for laparoscopic cholecystectomy if they are able to tolerate general anesthesia and have no serious car-

diopulmonary diseases or other comorbid conditions that preclude operation. In fact, the indications for laparoscopic cholecystectomy, in general, are similar to those for open cholecystectomy. Indeed, the availability of laparoscopic cholecystectomy should not expand the indications for gallbladder removal.

Patients who are usually not candidates for laparoscopic cholecystectomy include those with generalized peritonitis, septic shock from cholangitis, severe acute pancreatitis, end-stage cirrhosis of the liver with portal hypertension, severe coagulopathy unresponsive to treatment, known cancer of the gallbladder, and cholecystoenteric fistulas. In addition, patients in the third trimester of pregnancy should not usually undergo laparoscopic cholecystectomy because of risk of damage to the uterus during the procedure.

Patients with acute cholecystitis, acute gallstone pancreatitis that has subsided, prior surgery in the upper abdomen, and symptomatic gallstones in the second trimester of pregnancy may be candidates for laparoscopic cholecystectomy, providing the operating surgeon is experienced in treating patients with complex laparoscopic cholecystectomy problems. The use of laparoscopic cholecystectomy in patients in the first trimester of pregnancy is controversial because of the unknown effects of carbon dioxide pneumoperitoneum on the developing fetus. Obese candidates can undergo the procedure, unless the abdominal wall is so thick that the laparoscopic instruments will not reach the area of dissection. Patients with choledocholithiasis with or without jaundice can often be treated by laparoscopic cholecystectomy, but they may well require adjunctive therapy prior to, during, or after the cholecystectomy for diagnosis and treatment of the bile duct stones. Patients with chronic obstructive pulmonary disease can usually tolerate laparoscopic cholecystectomy, but the carbon dioxide used to insufflate the abdominal cavity during the operation may cause hypercarbia and acidosis. An experienced operating team should be able to successfully manage these groups of patients who have relative contraindications to the operation.

During the course of laparoscopic cholecystectomy, patients in whom the surgeon cannot clearly identify the anatomy of the gallbladder and portal region, in whom bleeding obscures the operative field, or in whom other problems develop during the operation that render laparoscopic cholecystectomy unsafe should have the procedure converted to an open cholecystectomy. Such a conversion is not a complication of laparoscopic cholecystectomy and should be done promptly to protect the patient from serious operative injury. This decision to convert to open cholecystectomy should be considered sound surgical judgment. It is implicit that only surgeons capable of performing open cholecystectomy and biliary surgery should perform laparoscopic cholecystectomy.

What are the alternative medical and surgical treatments of gallstone disease?

In the past 20 years, a variety of treatment options for gallstone disease have been developed. Dissolution of gallstones by both mechanical and biochemical means are available. These alternative methods of treating gallstones must be compared with the standard surgical modalities. Open cholecystectomy has become one of our safer surgical procedures as improved methods of surgical technique, better anesthesia, and management of comorbid conditions have evolved. The current issue in the modern treatment of gallstone disease has focused on the role of the new surgical procedure, laparoscopic cholecystectomy.

Oral dissolution therapy

Bile acid therapy with chenodiol was introduced in the early 1970s. However, because of concerns regarding side effects, chenodiol has been largely supplanted by ursodiol. The most effective use of bile acids in gallstone dissolution is in the symptomatic patient with small (less than 5-mm) floating cholesterol stones within a functioning gallbladder. This represents approximately 15% of patients. Six to 12 months of therapy are required in many patients, and monitoring is necessary until dissolution is achieved. It is estimated that gallstones in such patients have a 60% (less than 10-mm stones) to 90% (less than 5-mm stones) dissolution rate, but in about one half of these patients gallstones recur within 5 years. It is unknown what percentage of recurrent stones will give rise to symptoms. Currently, data are insufficient to support the use of maintenance bile acid therapy after stone dissolution. The chance of complete dissolution is poor in patients with larger and predominantly noncholesterol stones. It is not known whether the addition of hydroxymethylglutaryl coenzyme A reductase inhibitors to bile acid therapy will contribute to the dissolution rate, or if the use of nonsteroidal anti-inflammatory drugs will reduce recurrence rates. Dissolution rates are higher and recurrence rates are lower in patients with single stones, nonobese individuals, and young patients. It is not known if the natural history of recurrent stones is similar to that of the original stones. Currently, the indications for bile acid therapy are limited to patients with a comorbid condition that precludes a safe operation and to patients who choose to avoid operation.

Extracorporeal shock wave lithotripsy

Extracorporeal shock wave lithotripsy (ESWL) was introduced in the mid 1980s. Various methods of producing shock waves (spark gap and piezoelectric) have been developed and efficacy depends on the amount of energy delivered to the stone. At present, none of the ESWL machines have been approved by the Food and Drug Administration for routine clinical use in the United States. The group in Munich, Germany, and others have demonstrated stone clearance in up to 95% of symptomatic patients with solitary noncalcified gallstones less than 20 mm in diameter in a functioning gallbladder. Patients with 20-mm to 30-mm gallstones and those with up to three stones in a functioning gall-

bladder have stone clearance rates of about 60%. It is estimated that 16% of all patients with symptomatic gallstones would fall into one of these categories. Effective ESWL requires adjuvant ursodiol therapy. Recurrence is infrequent following therapy with ESWL for a single small stone but is more common in patients with multiple stones. The natural history of recurrent stones is unknown in terms of predicting recurrence of symptoms. Complications of ESWL are minor and include transient elevations of liver enzymes, pancreatitis, and hematuria. Effective ESWL depends on fragmentation of stones into much smaller pieces that can be dissolved or readily passed into the gut. The incidence of transient biliary pain has been reported to be as high as 45% after successful stone fragmentation.

Contact dissolution therapy

Considerably less experience is recorded in the use of contact dissolution agents. The most commonly used agents are methyl *tert*-butyl ether, which is experimental, and to a much lesser degree, monooctanoin, which is approved for the dissolution of bile duct stones. Methyl *tert*-butyl ether is usually introduced via a percutaneous transhepatic catheter into the gallbladder. Effective delivery and removal of solvent is facilitated by the use of an automatic peristaltic pump. Stones composed predominantly of cholesterol can be cleared in hours to days. This technique is most often used in patients who are high surgical risks. Little information is available regarding recurrence rates. Monooctanoin has been used primarily for dissolution of bile duct stones retained following surgery. Catheters are placed within the bile duct, either transhepatically or through a endoscope, and monooctanoin is perfused for a period of days via the indwelling catheter or an existing T tube. Methods have been described for the instillation of both contact agents into the gallbladder by endoscopic means. The use of contact dissolution agents has limited application in patients with gallstone disease.

Open cholecystectomy

This operation has been used for more than 100 years and is a safe and effective method for treating symptomatic gallstones. At laparotomy, direct visualization and palpation of the gallbladder, bile duct, cystic duct, and blood vessels allow safe and accurate dissection and removal of the gallbladder. Intraoperative cholangiography has been variably used as an adjunct to this operation. The rate of common bile duct exploration for choledocholithiasis varies from 3% in series of patients having elective operation to 21% in series that included all patients. Major complications of open cholecystectomy are infrequent and include common duct injury, bleeding, biloma, and infections. Open cholecystectomy is the standard to which other treatments must be compared and remains a safe surgical alternative.

Mini-laparotomy cholecystectomy

This modification of the open operation removes the gallbladder through a substantially smaller incision with the objective of reduced postoperative pain. Published data are limited to fewer than 200 patients highly selected for ease of surgical access. This small number precludes meaningful evaluation of this technique.

Cholecystostomy

Drainage of the gallbladder combined with stone removal may be achieved percutaneously or operatively under local anesthesia. Indications are limited to poor risk or debilitated patients with an obstructed gallbladder, in whom open operation or laparoscopic interventions are considered high risk. Occasionally, cholecystostomy is the appropriate operative procedure if open cholecystectomy becomes unsafe. Mortality rates of 10% to 12% are primarily related to comorbid disease states.

What are the results of laparoscopic cholecystectomy compared with open cholecystectomy and other available treatments?

The evaluation and comparison of outcomes of the various available therapeutic modalities are hampered by inherent limitations and by the type and quality of the available data. The rapidly evolving technology for the treatment of gallstones, especially laparoscopic cholecystectomy, presents a swiftly moving target for analysis. This not only complicates the comparison of studies conducted only a few years apart but necessarily limits analysis to a snapshot in time. Moreover, there is strong consensus that there is a rapid acquisition of appropriate technical skills associated with laparoscopic cholecystectomy, which is reflected in widely differing reported rates of morbidity. The following analysis therefore provides a general framework for the evaluation of outcomes, which should facilitate subsequent reanalysis in the face of anticipated further rapid progress.

Laparoscopic cholecystectomy owes much of its rapid growth to market forces generated, not inappropriately by patient demand. Hence, it is important to evaluate outcome from the point of view of the patients themselves, as well as by traditional medical criteria.

There are substantial limitations in quality and the quantity of the data available:

- Well-controlled studies are unavailable, and there is little prospect that such studies will be done. This is due largely to the unwillingness of patients to forgo treatment with the most advanced modality available.
- Bias toward the reporting of more favorable results is well recognized. While this bias is relevant to each of the treatment modalities, there is a strong probability that it is greater for laparoscopic cholecystectomy, associated with extraordinary competitive

pressure in a rapidly evolving field that includes the most common operation performed by the general surgeon. This is suggested by the fact that many major medical centers that are reporting relatively low rates of bile duct injury from laparoscopic cholecystectomy are simultaneously seeing an increased number of patients referred from outside hospitals for the treatment of such injuries. Thus, the reported data most likely underestimate the complication rates for laparoscopic cholecystectomy more than for open cholecystectomy.

- There is patient selection bias. While the early experience with laparoscopic cholecystectomy undoubtedly included a disproportionate number of relatively low-risk patients, more recent series are expanding the criteria for patient selection. Nevertheless, it seems likely that open cholecystectomy is performed in higher risk patients with more longstanding and more advanced biliary tract disease.
- There is a paucity of long-term follow-up data even for traditional procedures, and an absence of such data for laparoscopic cholecystectomy, which was introduced to this country just 3 years ago. This is particularly important for bile duct strictures, of which a substantial proportion present months or years following surgery.

Summary of outcomes

Laparoscopic cholecystectomy is a relatively new operation that provides a safe and effective alternative treatment for patients with symptomatic gallstones. It offers the substantial advantage over open cholecystectomy of markedly decreased pain and disability, without apparent increased mortality or overall morbidity. Although the rate of common bile duct injury is increased, this rate appears to be sufficiently low to justify the patient's selecting (with the counsel of a physician) this procedure for the treatment of symptomatic gallstones. Laparoscopic cholecystectomy can be performed at a medical treatment cost equal to or slightly less than that of open cholecystectomy and with substantial cost savings to the patient and society due to markedly reduced disability (Table 1). However, the results of laparoscopic cholecystectomy are greatly influenced by the skill and experience of the surgeon performing the procedure and reflect a steep learning curve. Because the conversion of laparoscopic to open cholecystectomy usually reflects sound surgical judgment, it should not be considered a complication of the procedure.

Open cholecystectomy remains a safe and effective procedure for the treatment of patients with symptomatic gallstones. Applicable to almost all such patients, the extensive experience with this time-honored operation makes it the standard with which all other procedures must be compared.

Oral bile acid therapy for dissolution of gallstones, with or without ESWL, provides a useful and safe, but ultimately less effective alternative therapy for selected patients, especially those whose medical condition and/or personal preference precludes operative cholecystectomy.

How should bile duct stones be detected and treated when laparoscopic cholecystectomy is or is not contemplated?

It is estimated that 8% to 15% of patients less than age 60 years and 15% to 60% of patients older than age 60 years undergoing cholecystectomy have common duct stones. These stones can be a major source of morbidity, and optimal care requires their detection and removal prior to a planned laparoscopic cholecystectomy, during cholecystectomy, or postoperatively.

Preoperative evaluation

The decision to evaluate the common duct for possible stones prior to planned laparoscopic cholecystectomy may be prompted by clinical suspicion alone or evidence of jaundice, recent pancreatitis, or a dilated common duct on imaging studies. If endoscopic retrograde cholangiopancreatography (ERCP) demonstrates a duct free of stones or containing a stone that can be removed endoscopically, subsequent laparoscopic cholecystectomy can be performed without the need for common duct evaluation and with detailed knowledge of the biliary anatomy. The success rate of endoscopic common duct stone extraction approaches 90% to 95% in expert hands. In situations where the surgeon or endoscopist is less experienced, percutaneous transhepatic cholangiography or ERCP should be considered prior to the operation to optimize all therapeutic options. In most instances, laparoscopic cholecystectomy can be performed within a few days after successful endoscopic sphincterotomy and stone removal. If there is failure to visualize the bile duct or inability to remove the stone at ERCP or percutaneous transhepatic cholangiography, the surgeon may elect to perform an open cholecystectomy with cholangiography and common duct exploration.

Intraoperative evaluation

While opinion is divided about the necessity of intraoperative cholangiography, all experienced surgeons stress the necessity of clear identification of ductal anatomy prior to excision of the gallbladder. High-quality cholangiography should be available in all centers, and experience in laparoscopic cannulation of the cystic duct should be part of the training of all surgeons performing laparoscopic cholecystectomy.

Options for management of common duct stones found at laparoscopic cholecystectomy include the following:

- conversion to open cholecystectomy and exploration of the common bile duct,

Table 1. Outcomes of Treatment Modalities for Gallstones

	Gallbladder Extirpation		Gallstone Ablation	
	Open Cholecystectomy	Laparoscopic Cholecystectomy	Lithotripsy	Oral Bile Acid Therapy
Applicability, %	98	90–95	7–16	15–30
Efficacy, rate of initial gallstone clearance, %	100	100	60–95	40–90
Adverse outcomes, %				
Mortality	<1[a]	<1[a]	~0	~0
Overall morbidity	4–8[b]	2–5[b]	~5	~0
Bile duct injury	0.1–0.2[c]	0.2–0.6[c]	0	0
Recurrence of gallstones	0	0	<50[d]	~50[d]
Costs				
Medical care costs, $[e]	X	0.9X-X	~X	~X
Disability, d[f]	20–40	7–14	1–2	<1
Patient preference issues				
Length of hospital stay, d	3–7	1–2	<1	0[h]
Discomfort	Severe	Mild	Mild[g]	None
Scar	Moderate	Minimal	None	None

[a] These figures are far more reflective of characteristics of patients in the group than they are of procedure used; they may range from <0.1% for selected elective operations to >2% for series including emergency operations and those including a substantial number of older and higher risk patients.

[b] These figures are far more reflective of characteristics of patients and how complications are defined in the group than they are of the procedure.

[c] These limits are based on extensive review of available published studies, studies and summaries presented at the conference, and information from two state registries. These comprise more than 200,000 open cholecystectomies and more than 100,000 laparoscopic cholecystectomies. The limits shown represent the range of the bulk of data and are not meant to include extreme values, expecially from the smaller series.

[d] Many of these recurrences are not symptomatic.

[e] As an example, the allowable rates for total (physician plus hospital) reimbursement by Blue Cross and Blue Shield in the national capital area are open cholecystectomy, $10,834; laparoscopic cholectystectomy; $8739. Values for lithotripsy and oral bile acid therapy are more variable, but approximate these values over the full course of treatment.

[f] Lost earnings due to absence from work are estimated to average $355 per week based on 1992 figures from the Bureau of Labor Statistics.

[g] Up to 45% of patients may have transient biliary pain.

[h] Although hospitalization is not required for oral bile acid therapy, several outpatient visits and tests are necessary for 6 to 12 months to safely monitor the course of treatment.

- laparoscopic exploration of the common duct (with options for mechanical stone extraction),
- postcholecystectomy ERCP (with sphincterotomy and/or mechanical stone extraction), and
- close monitoring of carefully selected patients for possible spontaneous stone passage.

Experience and training in these different therapeutic modalities are evolving rapidly, and the best management decision will often be based on the availability of local expertise.

Postoperative evaluation

A similar wide assortment of treatment modalities used to remove common bile duct stones before laparoscopic cholecystectomy is available to remove these stones detected after surgery.

Endoscopic retrograde cholangiopancreatography with endoscopic sphincterotomy and stone extraction with balloon catheter, basket, or mechanical lithotripters will be successful in the great majority of patients (about 90%). For large common bile duct stones that defy conventional extraction methods, ESWL or contact laser techniques may be successful in fragmenting the stone prior to subsequent removal. In some instances, prolonged common bile duct infusion of solvents has been helpful in reducing stone size or enhancing mechanical extraction.

In situations where patient anatomy or operator inexperience preclude successful endoscopic stone extraction, interventional radiologic therapy may be considered. The percutaneous transhepatic route enables the radiologist to use many of the stone extraction techniques used by the endoscopist or surgeon. In most circumstances, reoperation and open exploration of the common duct is necessary only if more conservative methods of common duct stone removal fail.

In that small group of patients with common duct stones and an intact gallbladder who are judged too ill or too frail to undergo cholecystectomy, endoscopic or radiologic techniques for removal of ductal stones offer a less invasive but effective therapeutic option.

What are the future directions for research in the prevention and management of gallstone disease and in laparoscopic surgery?

Current strategies are not aimed at the primary prevention of gallstones. This approach is based on data that indicate gallstone formation leads to clinically im-

portant sequelae in a minority of individuals who can be identified because of pain syndromes. Current management strategies begin after gallstones have already occurred and are targeted to the subset of patients with symptomatic gallstones. Such treatment aims both to rid the individual of existing gallstones and to prevent the formation of further stones. To date, no single therapeutic approach has been identified to accomplish both goals in the entire range of patients with gallstones. Success has been limited by variability in patients' general state of health, gallstone composition, size, number, and location, and treatment-related morbidity and mortality.

Fortunately, safe and effective treatment is already available for most patients with symptomatic gallstones. In patients at low risk for complications from general anesthesia, cholecystectomy achieves both goals of gallstone therapy. Emerging evidence suggests that, when performed by experienced surgeons, laparoscopic cholecystectomy is generally as safe and effective as open cholecystectomy, at least in the short term. However, at present it remains uncertain whether this preliminary impression, which is based on data reported by a select subset of expert surgeons, validly reflects the community experience with laparoscopic cholecystectomy. Accurate centralized registration of laparoscopic cholecystectomy and its associated morbidity and mortality by all operators is necessary in order to clarify this issue. Moreover, few data are available to assess differences in delayed adverse outcomes between the two approaches. Hence, prospective monitoring of long-term complications in patients treated with laparoscopic cholecystectomy is mandatory. Despite these limitations with the early data, the laparoscopic approach has already won patient acceptance and is being widely implemented. Thus, future research should attempt to identify strategies that minimize procedure-associated morbidity and optimize the cost-effectiveness of laparoscopic cholecystectomy. More data must be obtained to clarify the following issues on which there is no present consensus.

- What modifications of current laparoscopic techniques will minimize patient morbidity?

  Future research should focus on developing improved technology to maximize the safety of entering the peritoneal cavity, to enhance visualization of intra-abdominal anatomy, and to minimize dissection-related injuries.
- What is the best approach to identify and treat associated choledocholithiasis?

  Future studies should address the following areas of controversy: Which patients should be screened for common bile duct stones? Should these patients be screened preoperatively, intraoperatively, or postoperatively, and if so, by which technique? If common bile duct stones are found, should they be managed by operative common bile duct exploration, therapeutic endoscopy, lithotripsy, contact dissolution, or other approaches? What are the potential adverse, immediate, and long-term outcomes of various management options? How do the risks and cost-effectiveness of these treatments compare with that of leaving small, common duct stones untreated in this patient population?
- What strategies can be implemented to maximize the cost-effectiveness of laparoscopic cholecystectomy?

  Future studies should evaluate the costs and benefits of various dissection equipment, disposable vs reusable instruments, and inpatient vs outpatient surgery.

The single most important variable that determines the safety and efficacy of laparoscoic cholecystectomy is the skill and laparoscopic surgical experience of the surgeon performing the procedure. Consequently, it is imperative that detailed guidelines be established for surgeon training, determination of competence, certification, and continuous monitoring of quality. The development of such detailed guidelines will require the involvement of various professional societies, certification boards, the credentialing bodies of health care organizations, and educational oversight groups. The rapid dissemination of laparoscopic cholecystectomy outside the customary scientific and academic process of validation and review emphasizes the need for guidelines to be introduced and implemented promptly to deal with other novel surgical procedures.

It is likely that some patients will remain who elect nonsurgical treatment of their gallstones or who are not candidates for cholecystectomy. Optimal treatment of gallstones also must be defined in this subset. Ablation of existing stones is the most pressing need in many patients who are too ill to tolerate definitive cholecystectomy. Treatment options in such patients include oral bile acid therapy, mechanical obliteration or dissolution of stones by percutaneously or endoscopically positioned catheters or ESWL, and techniques that facilitate stone egress, such as endoscopic sphincterotomy or percutaneously or endoscopically placed biliary stends and cholecystostomy. Future studies should define which approaches provide maximal efficacy and safety in this group of patients.

Efforts should continue to develop a single, noninvasive approach, which will both eliminate existing stones and prevent recurrent stones. If such a treatment is developed, its safety and efficacy should be compared with that of cholecystectomy. If superior, the "new," noninvasive approach may ultimately render cholecystectomy obsolete. At that point, it may be appropriate to address whether this new treatment should be extended to asymptomatic patient with gallstones and gallstone-free subjects at risk for stone formation. Future research should identify which subsets of these high-risk populations should be targeted for prophylactic treatment and systematically evaluate the cost-effectiveness of strategies to prevent the development of symptomatic stones. The cost-effectiveness of all new prophylactic therapies must be weighed against that of currently available, inexpensive, and safe strategies, such as weight control and diet modification, which may have prophylactic efficacy.

Conclusions

- Most patients with gallstones remain asymptomatic. Asymptomatic patients usually develop symptoms before they develop complications. Therefore, with few exceptions, patients with asymptomatic gallstones should not be treated.
- Once gallstone symptoms appear, they tend to recur, and such patients are more prone to develop complications. Thus, most patients with typical biliary symptoms and gallstones should be treated.
- Because gallstones are so prevalent, they are often present incidentally in patients with other diseases. Patients with gallstones and atypical pain or dyspepsia need further investigation to determine the cause of their symptoms.
- Laparoscopic cholecystectomy provides a safe and effective treatment for most patients with symptomatic gallstones. Indeed, it appears to have become the treatment of choice for many of these patients.
- Laparoscopic cholecystectomy provides distinct advantages over open cholecystectomy. It decreases pain and disability without increasing mortality or overall morbidity. Although the rate of common bile duct injury appears to be increased, this rate is still sufficiently small to justify the use of laparoscopic cholecystectomy in the treatment of symptomatic gallstones.
- Laparoscopic cholecystectomy can be performed at a treatment cost that is equal to or slightly less than that of open cholecystectomy and with substantial cost savings to the patient and society due to reduced loss of time from work.
- The outcome of laparoscopic cholecystectomy is influenced greatly by the training, experience, skill, and judgment of the surgeon performing the procedure.
- During laparoscopic cholecystectomy, when the anatomy is obscured, excessive bleeding occurs, or other problems arise, the operation should be converted promptly to open cholecystectomy. Conversion under these circumstances reflects sound surgical judgment and should not be considered a complication of laparoscopic cholecystectomy.
- Open cholecystectomy is a safe and effective operation for symptomatic gallstone disease. Because of its wide applicability and low mortality and morbidity, open cholecystectomy remains a standard against which new treatments should be judged.
- Oral bile acid therapy, with or without ESWL, provides a useful and safe, but ultimately less effective, alternative therapy for selected patients. This modality may be indicated for patients whose medical condition and/or personal preference precludes operative cholecystectomy.
- Contact dissolution of gallstones by solvents currently has limited clinical applicability.
- Depending on the availability of technical expertise in endoscopic and laparoscopic exploration of the common duct, valid treatment options for common bile duct stones include preoperative, intraoperative, or postoperative identification and removal of stones.
- Surgeons performing laparoscopic cholecystectomy should possess the skills necessary to perform intraoperative cholangiography. Training in laparoscopic common bile duct exploration is encouraged.
- Future research should focus on refining the technique of laparoscopic cholecystectomy to maximize safety and cost-effectiveness of the procedure.
- Strict guidelines for training in laparoscopic surgery, determination of competence, and monitoring of quality should be developed and implemented promptly. The formulation of such guidelines will require the involvement and cooperation of various professional societies, credentialing committees, certification boards, and educational oversight groups.
- Safe, noninvasive, cost-effective strategies to prevent gallstones should be actively sought.

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Speakers were:

Jeffrey S. T. Barkun, MD, FRCSC: "Laparoscopic Versus Mini-Cholecystectomy: Canadian Experience"

Eric B. Bass, MD, MPH: "Cost-Effectiveness of Laparoscopic Cholecystectomy Versus Open Cholecystectomy"

Harvey Bernard, MD: "Complications After Laparoscopic Cholecystectomy"

Martin C. Carey, MD, DSc, FRCPI: "Pathogenesis of Gallstones"

David L. Carr-Locke, MD, FRCP: "Gallstone Pancreatitis: Endoscopy"

Peter B. Cotton, MD, FRCP: "Treatment of Choledocholithiasis: Endoscopic Management"

Robert J. Fitzgibbons, Jr, MD: "Gallbladder and Gallstone Removal, Open Versus Closed Laparoscopy, and Pneumoperitoneum"

Gary D. Friedman, MD: "Natural History of Asymptomatic and Symptomatic Gallstones"

Thomas R. Gadacz, MD: "Laparoscopic Cholecystectomy: US Experience"

Alan F. Hofmann, MD, PhD: "Primary Prevention of Symptomatic Cholesterol Gallstone Disease"

John G. Hunter, MD: "Exposure, Dissection, and Electrocautery vs Laser for Performance of Laparoscopic Cholecystectomy"

Charles K. McSherry, MD: "Open Cholecystectomy"

William C .Meyers, MD: "Complications of Laparoscopic Cholecystectomy"

Frank G. Moody, MD: "Lithotripsy in the Treatment of Biliary Stones"

David L. Nahrwold, MD: "Gallstone Lithotripsy"

Douglas O. Olsen, MD: "Mini-lap Cholecystectomy: Is Smaller Better?"

Carlos A. Pellegrini, MD: "Gallstone Pancreatitis: Surgery"

Jacques Perissat, MD: "Laparoscopic Cholecystectomy: European Experience"

Joseph B. Petelin, MD: "Laparoscopic Approach to Common Duct Pathology"

Edward H. Phillips, MD: "Routine vs Selective Cholangiography"

Henry A. Pitt, MD: "Open Choledochostomy"

Leslie J. Schoenfield, MD, PhD: "Oral and Contact Dissolution of Gallstones"

Nathaniel J. Soper, MD: "Nonbiliary Problems Impacting on Laparoscopic Cholecystectomy"

Steven M. Strasberg, MD, FRCSC: "Overview of Treatments for Cholesterol Gallstones"

L. William Traverso, MD: "Clinical Manifestations and Impact of Gallstone Disease"

John V. White, MD: "The National Laparoscopic Surgery Registry: Assessment of Laparoscopic Cholecystectomy and the Future of Laparoscopic Surgery"

Karl A. Zucker, MD: "Laparoscopic Management of Acute Cholecystitis"

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