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# Preoperative Screening for Common Bile Duct Stones With Infusion Cholangiography

## Review of 1000 Patients

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**Objective**
The authors aimed to study the safety and accuracy of infusion cholangiography in patients undergoing laparoscopic cholecystectomy.

**Summary Background Data**
Intravenous cholangiography is a theoretically attractive method of screening the common bile duct for stones. However, there still remain serious reservations regarding its safety and accuracy, despite some reports in the literature to the contrary.

**Methods**
A personal series of 1000 patients undergoing routine preoperative infusion cholangiography was reviewed.

**Results**
The cholangiograms detected bile duct stones with a sensitivity of 93.3% and a specificity of 99.3%. There were no serious contrast reactions, and the minor contrast reaction rate was 0.7%.

**Conclusions**
The authors conclude that infusion cholangiography is indeed safe and accurate and should play a substantial role in preoperative screening for incidental common bile duct stones.

Laparoscopic cholecystectomy is now the gold standard for treatment of symptomatic gallstones, and at least 80% of patients are treated this way.[1]

Common bile duct stones were known to occur in approximately 15% of patients undergoing open cholecystectomy,[2] but the true incidence in the laparoscopic era is probably lower, reported to be between 5% and 10%.[3,4]

The advent of laparoscopic cholecystectomy has challenged our traditional approach to the management of duct stones, but the optimal method remains controversial. That the stones should be treated is not open to

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question. Although some stones can pass uneventfully, studies have shown the risk of duct stones giving rise to complications is 25% to 50%.[5]

Various screening options have evolved in the laparoscopic era. One can elect to detect and remove stones before surgery. Selective endoscopic retrograde cholangiopancreatography (ERCP), based on predictors of common duct stones such as abnormal liver function test results or duct dilatation, is an example of this approach and is the most commonly used option among surgeons at present.

Alternatively, one can undertake screening intraoperatively. If stones are detected on intraoperative cholangiography, they can be removed immediately at laparoscopic or open duct exploration, or later with postoperative ERCP.

Another option, infrequently used, is preoperative infusion cholangiography. If the duct is clear, the patient goes on to laparoscopic cholecystectomy; if stones are found, they are removed at ERCP before the patient goes on to surgery. In the past, dangerous contrast reactions and an unacceptably high rate of suboptimal studies led to a decline in its popularity.[6] However, recent modification of the contrast agent and the use of tomography have improved its accuracy and safety.[7] These modifications unfortunately coincided with the emergence of ERCP and, with the advent of laparoscopy, the investigation faded into obscurity as ERCP became the primary tool for screening for duct stones. The literature showed its safety and accuracy, but because infusion cholangiography had not enjoyed a Renaissance in the laparoscopic era, we sought to establish this beyond all doubt.

## METHODS

A personal series of 1000 patients of a cohort of 1100 patients undergoing laparoscopic cholecystectomy for symptomatic gallstones between June 1991 and November 1995 had routine preoperative infusion cholangiograms performed. The patients had their records reviewed, and data had been recorded prospectively. Follow-up ranged from 1 to 52 months and involved clinical and postal questionnaire assessment.

One hundred patients were excluded. Reasons for this included patients presenting with jaundice or ascending cholangitis, iodine allergy, duct stone seen on ultrasound, pregnancy, patient investigated elsewhere, patient refusal, and undetermined.

The protocol in Figure 1 was followed. Patients with a clear cholangiogram went to laparoscopic cholecystectomy. Those with a cholangiogram showing stones underwent preoperative ERCP and had their duct cleared, where possible, before going on to surgery. If this failed, then a planned laparoscopic duct exploration was performed.

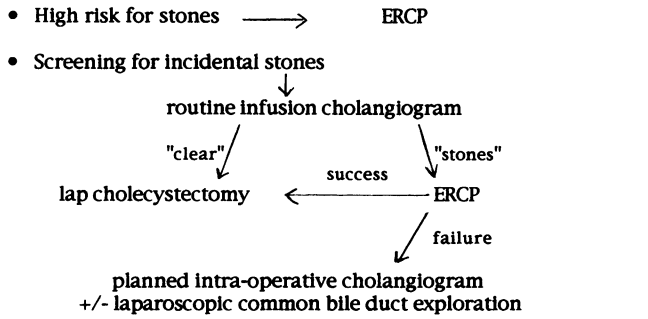


**Figure 1.** Protocol for management of duct stones.

If the cholangiogram was equivocal–unsatisfactory, then predictors of duct stones were relied on. Where these suggested stones, an ERCP was performed. The parameters studied were as follows:

1. The presence or absence of liver function test result abnormalities.
2. The presence or absence of stones, as well as duct dilatation, on cholangiogram reports.
3. The presence or absence of stones at ERCP when performed.
4. Contrast reactions as recorded by the radiologist.

The technique of cholangiography followed a strict protocol. A bolus of meglumine–iotroxate was administered by slow intravenous infusion over the course of 30 minutes, and several tomograms were taken. The test was organized at the time of booking surgery and was performed on an outpatient basis.

## RESULTS

### Cholangiograms

There were 43 positive, 935 negative, and 22 equivocal–unsatisfactory cholangiogram reports for stones. Forty-two of 43 patients with positive reports had stones confirmed at ERCP. There was a single false-positive.

Of 935 patients with negative cholangiogram reports, 1 represented with a retained stone, giving a single false-negative. Twenty-two patients had equivocal–unsatisfactory cholangiograms and of these, 5 patients went on to ERCP and 17 did not. All 5 ERCPs were clear, and of the 17 not undergoing ERCP, 2 represented at 2 and 4 months with retained stones (both of these patients' liver function test results were normal at initial assessment).

The sensitivity of the cholangiograms in our patients was thus 93.3% (42 of 45 stones detected). This includes the two retained stones in which the cholangiogram was

**Table 1. CHOLANGIOGRAM SENSITIVITY AND SPECIFICITY FOR STONES**

| | |
|---|---|
| Sensitivity (%) | 93.3 |
| Specificity (%) | 99.4 |

equivocal–unsatisfactory, yet the patient did not go on to ERCP, as well as the single false-positive.

The specificity of the cholangiograms was 99.3% (single false-positive and 5 negative ERCPs for equivocal–unsatisfactory cholangiograms, giving 934 of 941 accurate studies) (Table 1).

## Proven Stones

Forty-five patients had proven stones. Of these, 41 were found at ERCP, and 4 represented after surgery with retained stones (Table 2). This means that the retained stone rate was 0.4% of patients and 8.9% of stones. One of the four was missed by the cholangiogram, two were equivocal but did not go on to ERCP, and one was seen at cholangiography but not on subsequent ERCP.

## Endoscopic Retrograde Cholangiopancreatography

Of 48 patients who had ERCPs, 41 stones were found, with 39 being removed successfully. In two patients, the ERCP failed, and the stone was extracted successfully at planned laparoscopic common bile duct exploration without complication. There was an ERCP rate of 4.8% and a negative ERCP rate of 14.6%.

## Liver Function Tests

We defined abnormal liver function test results as an elevation of at least 10% in at least one of the liver function tests (bilirubin; alkaline phosphatase; aspartate aminotransferase; Alinine aminotransperase; gamma transferase glutamyl). Of patients with stones, there was a similar number of patients with normal and abnormal liver function test results, and 31% of those without stones had abnormal liver function test results. The sensitivity and specificity for stones were 46.7% and 69.2%, respectively.

# DISCUSSION

## Incidence of Common Duct Stones

Important in evaluating the size of the problem is appreciating the incidence of common duct stones in the laparoscopic era. Although this was accepted to be around 15% in the open era, a more accurate figure now is approximately 10%, with approximately half of these being asymptomatic. Our study bears these figures out, with an incidence of unsuspected stones of 4.5% and approximately 5% of patients coming to immediate ERCP with symptomatic stones.

## Evolution of Infusion Cholangiography

Infusion cholangiography was never a popular examination with radiologists. Some reported rather poor opacification of the biliary tree. The incidence of severe, life-threatening reactions was several fold higher than for uroangiographic-iodenated contrast agents.[6,8]

The search for better agents in the 1970s led to the synthesis of two new substances, iodoxamate and iotroxate. These are, like the older agents, dimers and trimers of triiodobenzoic acid, but they differ in the length and nature of the interconnecting chain.

In 1978, a new agent (biliscopin–meglumine iotroxate; Schering AG, Berlin, Germany) became commercially available. It was claimed to achieve higher concentrations in bile and at least when infused slowly to be less allergenic.[9]

Review of the literature of all biliary intravenous contrast agents shows a wide range in reaction rates from 0% to 25%.[7] The overall rate for iotroxate is 7%, the lowest of any agent. Furthermore, when the subgroup of patients having iotroxate by slow infusion is looked at, the rate is much lower.

Unfortunately, infusion cholangiography remains in relative obscurity. In fact a recent editorial concludes: "The efficacy and safety of IVC with the new agent has not, in our opinion been firmly established. In these circumstances we do not feel its routine use preoperatively in patients being considered for laparoscopic cholecystectomy can be justified."[10]

Table 3 lists that we have confirmed and improved on the findings of others regarding the efficacy and safety of infusion cholangiography.[11–14] Little data exist in the laparoscopic era.

**Table 2. PROVEN STONES**

| | |
|---|---|
| Patients without stones | 955 |
| Patients with stones | 45 |
| Stones detected at ERCP | 41 |
| Retained stones | 4* (0.4% of patients) (8.9% of stones) |

ERCP = endoscopic retrograde cholangiopancreatography.
* One missed by cholangiography, one seen at cholangiography but not at subsequent ERCP, and two "equivocal" at cholangiography.

**Table 3. COLLECTED PUBLISHED SERIES ON INFUSION CHOLANGIOGRAPHY**

| Author | Year | No. of Patients | Accuracy (%) | Sensitivity (%) | Specificity (%) | Equivocal Rate (%) | Severe Reaction Rate (%) | Minor Reaction Rate (%) |
|---|---|---|---|---|---|---|---|---|
| Goransson | 1980 | 534 | 98.6 | — | — | 10 | — | — |
| Alinder | 1986 | 200 | — | 90.9 | 99.5 | 10 | 0 | 2 |
| Daly | 1987 | 286 | 98.0 | — | — | — | 0 | 2 |
| Huddy | 1989 | 57 | — | 87.5 | 96.5 | 5.3 | 0 | — |
| Joyce | 1991 | 100 | — | 87.5 | 99.0 | — | 0 | — |
| Nottle | 1997 | 1000 | — | 93.3 | 99.3 | 2.2 | 0 | 0.7 |

## Intraoperative Cholangiography

If infusion cholangiography then is safe and accurate, how does it compare with other approaches? Intraoperative cholangiography is as accurate[14] and is probably good practice for those wanting to undertake laparoscopic duct explorations. However, this is not an indication for its use.

Intraoperative cholangiography is said to help protect against duct injury by providing an anatomic "roadmap."[15,16] However, there is no direct evidence that it does prevent injury. Andren–Sandberg et al.[17] showed in a study of 55 injuries that more than half occurred before the surgeon had seen the films and only 16 had aberrant anatomy. Clearly, patients with normal anatomy are not immune from duct injury, and x-rays are not a substitute for careful dissection.

The procedure is time consuming, adding 10 to 15 minutes to every operation. Theater time is precious and expensive and should not be wasted on screening efforts. It has a failure rate of up to 25%.[18,19] The unexpected finding of a stone turns a relatively simple procedure into a much longer and more difficult operation if a laparoscopic duct exploration is undertaken. This adversely impacts on a planned list, and case cancellations ensue inevitably. If the patient is opened, the laparoscopic advantage is lost, and if postoperative ERCP is relied on, then one runs the risk of a postoperative bile leak or a failed stone extraction, necessitating reoperation. If a laparoscopic common bile duct exploration is to be performed and it can be performed safely and successfully,[20,21] then it should be anticipated, time set aside, and the procedure explained fully to the patient.

## Selective Endoscopic Retrograde Cholangiopancreatography

How does our approach compare with selective ERCP? Endoscopic retrograde cholangiopancreatography is highly accurate at detecting duct stones, and successful extraction can be expected in between 54% and 95% of cases, but in good hands, successful extraction should be at approximately 90%.[22,23] It has, like infusion cholangiography, the advantage of dealing with stones before surgery, which helps tactical planning immensely.

Against this, selective ERCP is invasive, expensive, and highly staff- and equipment-intensive. It has a documented mortality and morbidity of 1% and 5% to 10%, respectively.[22] Therefore, any means of reducing its unnecessary use seems logical.

Unfortunately, selective ERCP relies on relatively inaccurate predictors of stones. These have been widely stud-

**Table 4. COMPARISON OF INFUSION CHOLANGIOGRAPHY AND 'PREDICTORS' IN TERMS OF POSITIVE PREDICTIVE VALUE AND DETECTION RATE FOR STONES AND ERCPs GENERATED (DEPENDING ON THE THRESHOLD FOR THE NUMBER OF POSITIVE PREDICTORS)**

| | Predictors (number of abnormal LFTs/presence of dilated duct) | | | | | Infusion Cholangiography |
|---|---|---|---|---|---|---|
| | 1 | 2 | >2 | >2 + DD | DD Alone | |
| Positive predictive value (%) | 3 | 3 | 20 | 35 | 56 | 98 |
| Stone detection rate (%) | 40 | 27 | 22 | 16 | 53 | 93 |
| ERCP rate (%) | 31 | 13 | 5 | 2 | 4 | 5 |
| Unnecessary ERCP rate (%) | 94 | 90 | 80 | 65 | 44 | 15 |
| Total ERCPs | 308 | 125 | 50 | 20 | 43 | 48 |

ERCP = endoscopic retrograde cholangiopancreatography; LFT = liver function test; DD = dilated duct.

ied in the prelaparoscopic era, with reports disparate in their conclusions and different parameters performing variably.[5] In our own series, the sensitivity and specificity rates of liver function test results for stones were poor. An important recent finding has been that an unnecessary ERCP rate of between 40% and 90% will ensue if these predictors are relied on, depending on how liberally they are applied.[23]

Table 4 lists the substratification of abnormalities in our patients with abnormal predictors, that is, liver function test results and duct diameter. It shows that no number of abnormal predictors predicted stones adequately, and many stones would have been missed. In addition, the number of negative ERCPs generated would be unacceptably high if a selective ERCP policy had been applied to our patients. The sensitivity and specificity of infusion cholangiography is included for comparison. Clearly, it outperforms the predictors and leads to a more appropriate use of ERCP with an unnecessary rate of only 14.6%.

Our approach to common duct stone management may not enjoy widespread adoption, as most surgeons by now will have settled on a method that they feel comfortable with and that generally serves them well. Furthermore, those who have residual suspicions about the safety and efficacy of infusion cholangiography or believe operative cholangiography prevents duct injury are unlikely to find favor with this approach.

We conclude that infusion cholangiography is indeed safe and accurate in diagnosing common bile duct stones before surgery. We think it is an underutilized investigation for screening. We recommend its use in the workup of patients being considered for laparoscopic cholecystectomy and suggest a protocol for management of duct stones incorporating routine screening with infusion cholangiography.

## References


1. Gallstones and laparoscopic cholecystectomy: NIH consensus and development panel on gallstones and laparoscopic cholecystectomy. JAMA 1993; 269:1018–1024.
2. Madden JL. Common duct stones. Their origin and surgical management. Surg Clin North Am 1973; 53:1095–1110.
3. Carroll BJ, Phillips EH, Chandra M, Fallas M. Laparoscopic transcystic duct balloon dilatation of the sphincter of Oddi. Surg Endosc 1993; 7:514–517.
4. Hunter J. Laparoscopic transcystic common bile duct exploration. Am J Surg 1992; 163:53–58.
5. Johnson AG, Hosking SW. Appraisal of the management of bile duct stones. Br J Surg 1987; 74:555–560.
6. Ansell G. Adverse reaction to contrast agents. Invest Radiol 1970; 5:374–391.
7. Nilsson U. Adverse reactions to iotroxate at intravenous cholangiography. A prospective clinical investigation and review of the literature. Acta Radiologica 1987; 28:571–575.
8. Shehadi WH. Adverse reactions to intravenous administered contrast media; a comprehensive study on a prospective survey. Am J Roent 1975; 124:145–152.
9. Taenzer V, Volkart V. Double blind comparison of meglumine iotroxate, meglumine iodoxate and meglumine ioglycate. Am J Roent 1979; 132:55–58.
10. Dawson P, Adam A, Benjamin IS. Intravenous cholangiography revisited (Editorial). Clin Radiol 1993; 47:223–225.
11. Alinder G, Nilsson U, Lunderquist A, et al. Preoperative infusion cholangiography compared to routine operative cholangiography at elective cholecystectomy. Br J Surg 1986; 73:383–387.
12. Daly J, Fitzgerald T, Simpson CJ. Pre-operative intravenous cholangiography as an alternative to routine operative cholangiography in elective cholecystectomy. Clin Radiol 1987; 38:160–163.
13. Huddy SP, Southham JA. Is intravenous cholangiography an alternative to the routine pre-operative cholangiogram? Postgrad Med J 1989; 65:896–899.
14. Joyce WP, Keane R, Burke GJ, et al. Identification of bile duct stones in patients undergoing laparoscopic cholecystectomy. Br J Surg 1991; 78:1174–1176.
15. Fletcher DR. Biliary injury at laparoscopic cholecystectomy: recognition and prevention. Aust N Z J Surg 1993; 63:673–677.
16. Bile duct injury during laparoscopic cholecystectomy: a report of the Standards Subcommittee of the Victorian State Committee of the Royal Australasian College of Surgeons. Aust N Z J Surg 1993; 63:682–683.
17. Andren–Sandberg A, Alinder G, Bengmark S. Accidental lesions of the common bile duct at cholecystectomy. Ann Surg 1985; 201:328–332.
18. Graves HA, Ballinger JF, Anderson WJ. Appraisal of laparoscopic cholecystectomy. Ann Surg 1991; 213:655–662.
19. Schirmer BD, Edge SD, Dix J, et al. Laparoscopic cholecystectomy treatment of choice for symptomatic cholelithiasis. Ann Surg 1991; 213:665–676.
20. Fielding GA, O'Rourke NA. Laparoscopic common bile duct exploration. Aust N Z J Surg 1993; 63:113–115.
21. Phillips EH, Liberman M, Carroll BJ, et al. Bile duct stones in the laparoscopic era. Arch Surg 1995; 130:880–886.
22. Lambert ME, Betts CD, Hill J, et al. Endoscopic sphincterotomy: the whole truth. Br J Surg 1991; 78:473–476.
23. Rijna H, Borgstein PJ, Meuwissen SGM, et al. Selective preoperative endoscopic retrograde cholangiopancreatography in laparoscopic biliary surgery. Br J Surg 1995; 82:1130–1133.