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Intraoperative cholangiography during laparoscopic cholecystectomy

Routine vs selective policy

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Abstract. An audit of routine intraoperative cholangiography in a consecutive series of 496 patients undergoing laparoscopic cholecystectomy has been performed. Cannulation of the cystic duct was possible in 483 patients (97%). The use of portable, digitized C-arm fluorocholangiography was vastly superior to the employment of a mobile x-ray machine and static films in terms of reduced time to carry out the procedure and total abolition of unsatisfactory radiological exposure of the biliary tract. Repeat of the procedure was necessary in 22% of cases when the mobile x-ray equipment was used. Aside from the detection of unsuspected stones in 18 patients (3.9%), routine intraoperative cholangiography identified four patients (0.8%) whose management would undoubtedly have been disadvantaged if intraoperative cholangiography had not been performed.

Key words: Laparoscopic cholecystectomy – Intraoperative cholangiography – Digitized fluorocholangiography – Ductal anomalies – Unsuspected stones

There remains considerable controversy regarding the need for routine intraoperative cholangiography during the performance of laparoscopic cholecystectomy (LC). Early French reports indicated that preoperative infusion intravenous cholangiography with iotroxate meglumine provided the necessary anatomical information on the majority of patients, thereby obviating the need for radiological visualization of the biliary tract during the operation [5, 13]. This view has not been substantiated by subsequent studies [4] and preoperative intravenous cholangiography is not practiced widely. There is general agreement that preoperative endoscopic retrograde cholangiography (ERC) should be employed selectively in patients with high-risk factors for ductal calculi—e.g. in those with dilated duct on ultrasound and abnormal liver function tests (LFTs) and in those patients with cholangitis and acute pancreatitis. Some would limit preoperative ERC only to the latter group [16]. The logical consequence of this approach is recourse to routine intraoperative cholangiography to exclude ductal disease and outline important anomalies of the biliary tract in all patients [1, 6, 8, 14]. This view is, however, challenged by some who maintain that laparoscopic cholecystectomy can be performed safely without this investigation [7, 10, 12]. The arguments expressed against routine intraoperative cholangiography have been several: It adds to the operating time and costs, is often unsatisfactory, and does not contribute to increased safety of the procedure. The key issue here is the incidence of iatrogenic bile duct injury. Although hard data are not available, the reported experience from tertiary centers concerning the number of bile duct strictures referred for remedial surgical treatment indicate a three- to fourfold increased incidence of iatrogenic bile duct damage since the advent of laparoscopic cholecystectomy [3, 11]. In the investigation of this problem, we have addressed two aspects of intraoperative cholangiography during LC: Does the equipment used matter? How often does it provide information which alters or influences surgical management during this intervention?

Patients, materials, and methods

The data are based on consecutive 495 patients in whom an LC was completed out of a total of 506 patients undergoing this procedure on an elective basis. The reason for conversion in 10 was technical inability to dissect the triangle of Calot with safety. Another patient was converted because of the findings of operative cholangiography. There were no instances of enforced conversion. The routine preoperative workup consisted of LFTs and biliary ultrasound. Abnormal LFTs (bilirubin, alkaline phosphatase, or γ-glutamyltranspepti-

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dase) were present in 52/506 patients. An ERC was performed in these patients preoperatively and 29 had confirmed ductal calculi. Preoperative endoscopic stone extraction was attempted in 19 and was successful in all but one (large occluding 3.0 cm calculus). Laparoscopic stone clearance (transcystic $n = 6$, common duct exploration $n = 5$) was performed successfully in 11, including the patient with failed preoperative endoscopic stone extraction.

An operative cholangiogram was attempted in all 496 patients. The technique used for cystic duct cannulation was standard throughout the entire experience. After dissection, the lateral end of the cystic duct was clipped. A small anterosuperior incision was made on the cystic duct with curved microscissors. A Fr 5 Cook ureteric catheter loaded inside the Storz cholangiograsper and attached to two syringes (sodium diatrizoate 20%, isotonic saline) was inserted into the cystic duct and held in place by approximation of the jaws of the cholangiograsper. Injection of saline during catheter insertion greatly facilitates catheter insertion into the cystic duct.

For the first 286 patients, the equipment used for radiological visualization consisted of a mobile x-ray machine and three blind films taken after injection of 2.0, 4.0, and 8.0 ml of contrast. In the succeeding 210 patients, fluorocholangiography using the Diasonics digitized C-arm (OEC Diasonics, Utah) was employed. This modern intensifier has digital facilities and an expanded software which enables image storage and advanced image processing: Zoom facility, real-time subtraction, road mapping, etc. When required as in the definition of minor cholangiographic details and suspect filling defects, boosted fluoro and peak opacification are employed to provide superb image quality with high-grade resolution. By use of a foot-operated switch during screening, desired images are selected as they appear on the screen and stored on hard disk from which permanent copies can be obtained on x-ray film cassettes within minutes by exposure of the image to the multiformat camera (Figs. 1, 2).

A time-related efficacy audit was carried out comparing the mobile x-ray/static films technique with digitized fluorocholangiography. Duration times for the cholangiography procedure were available for 90 patients in the former group and in 100 patients in the fluorocholangiography arm. For this aspect of the study, the following definitions were employed:

1. Satisfactory radiological visualization: entire intra- and extrahepatic biliary tree visualized with appropriate definition so as to enable an unequivocal verdict by the operating surgeon.
2. Time for cholangiography: Interval in minutes from the start of injection until dispensing with the radiological equipment.

Fig. 1. Small stones in the distal common bile duct, which is not dilated.

Fig. 2. Small stone in the ampullary region of an otherwise-normal common bile duct.

Results

Cannulation of the cystic duct was successful in 483/496 (97%) patients. In the unsuccessful-cannulation group, two patients had a large impacted stone which could not be dislodged in Hartmann's pouch. In the remaining 11 patients the catheter could not be introduced for reasons that were not apparent, but the surgeon assumed that redundancy of the cystic-duct mucosal folds (prominent Heister valve) was the cause. The occurrence of this eventuality did not appear to be related to the number of cases performed, and it would appear that a small percentage of cystic ducts are perhaps too narrow or tortuous to be cannulated with a Fr 5 catheter. One instructive case was encountered. Resistance to the advancement of the catheter tip was accompanied by a grating sensation. After withdrawal of the catheter tip, milking of the cystic duct by an atraumatic forceps in a lateral direction resulted in the retrieval of a cystic duct stone, after which a normal cholangiogram was performed (Fig. 3).

The results of the time-efficacy audit of the two equipment modes are shown in Table 1. In contrast to operative-time saving and satisfactory visualization of the entire biliary tract in all the patients by digitized fluorocholangiography, there was a high incidence of unsatisfactory exposure by the mobile x-ray/static-films technique, necessitating repeat of the procedure in 22% of cases.

The findings of operative cholangiography for the entire series are outlined in Table 2. Aside from the detection of stones, operative cholangiography influenced the intraoperative procedure in 23/483 patients (4.8%). In the majority ($n = 20$), this related to securing the medial end of the cystic duct without compromise of the integrity of the extrahepatic biliary con-

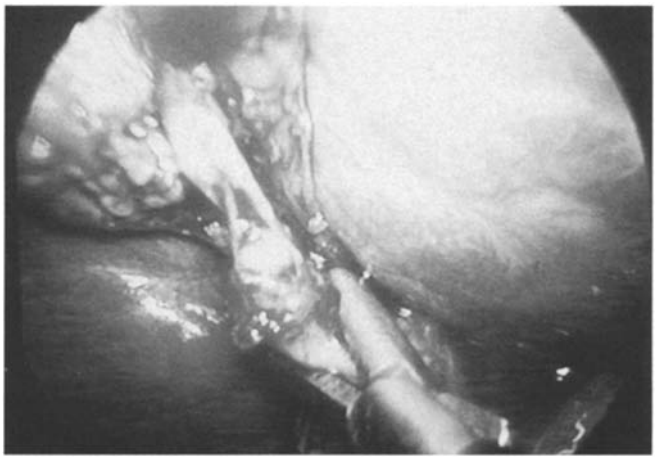

Fig. 3. Unsuspected stone massaged out of the cystic duct. Suspicion was raised when the cystic duct could not be negotiated by the cholangiography catheter. The intraoperative cholangiogram of this patient was normal.

Table 1. Time-efficacy audit of laparoscopic cholangiography

Cholangiography mode	Time[a]	Unsatisfactory films
Portable x-ray machine	23 (16–49)	62/280[b]
Digitized C-arm	4 (3–20)	0/203

[a] Time in minutes—median (range)—from start of injection to completion for 90 portable x-ray and 100 C-arm procedures. $P < 0.001$ (Mann-Whitney U test)
[b] Rate after first three blind films had been developed

Table 2. Findings of operative cholangiography during laparoscopic cholecystectomy

Abnormality	*n*	Total cases
Unsuspected stones[a]	18 (3.9%)	454
Biliary-tract anomalies[b]	58 (12.0%)	483
Short cystic to common hepatic	12 (2.5%)	483
Short cystic to right hepatic	8 (1.7%)	483
Accessory duct	2 (0.4%)	483
Hilar cholangiocarcinoma	1 (0.2%)	483

[a] Normal preoperative LFTs and biliary ultrasound, includes instance of cystic-duct stone
[b] Includes spiral insertion, low insertion, and parallel run

duit. As is our custom, this was achieved by ligature in continuity using the Roeder knot with dry chromic catgut, but in two patients the duct was so short that closure by suture using 4/0 coated Vicryl was necessary. The only instance of accessory duct was also suture ligated. The unsuspected hilar cholangiocarcinoma was encountered in an 80-year-old patient with no clinical jaundice but with elevation of the serum alkaline phosphatase before surgery. If the number of patients with unsuspected stones detected by intraoperative cholangiography ($n = 18$) is considered in the argument and laparoscopic stone extraction is added to the cholecystectomy (as is the authors' practice), then surgical management is influenced by cholangiography in 8.5% of cases.

Discussion

This study has demonstrated the superiority of fluorocholangiography over the use of the mobile x-ray machine with blind static films in the performance of cholangiography during laparoscopic cholecystectomy. Two practical advantages of digitized C-arm image intensifiers must be emphasized: The ability to visualize the entire biliary tract in all the patients and the significant reduction in the time needed to complete the procedure. If the C-arm unit is operated by certified users among the surgical team and other theater staff (dispensing with the need of a radiographer), cost savings are also incurred.

The detection of a cystic-duct stone as a result of a failed initial attempt at its cannulation is instructive; it highlights the distinct possibility that dislodgement of small gallstones into the extrahepatic ductal system following laparoscopic manipulation of the gallbladder prior to ligature of the cystic duct may not be an uncommon event during this operation.

In this study 23/483 cholangiograms (4.8%) yielded important information which influenced the course of action taken by the surgeon during the operation. Undoubtedly in four, (0.8%) the patients would have been disadvantaged if a cholangiogram had not been performed: Two cases requiring suture closure of the medial end of the cystic duct, one patient with accessory duct joining the gallbladder neck and one patient with hilar cholangiocarcinoma. Thus, although the vast majority of cases could have been performed with complete safety without cholangiography, partial occlusion of the extrahepatic bile duct would have been enacted in 2/483 patients (0.4%) if blind clipping/ligature of the medial end of the cystic duct was practiced, and another patient would have had a significant postoperative biliary fistula. The avoidance of bile-duct injury is surely the most compelling reason for routine intraoperative cholangiography.

In addition, unsuspected stones were detected by cholangiography in 18 patients (3.9%) and a cystic duct stone was identified because of difficulty in cannulation of the cystic duct. The detection of these stones is important, since although some will pass spontaneously, others will not and are likely to cause life-threatening complications. Since there is no definitive information available which can reliably predict the subsequent course of these unsuspected calculi in the individual patient, the sensible management option is to remove them, and in the authors' view, the optimum time for this is during the procedure itself, either by extraction through the cystic duct or by direct laparoscopic bile-duct exploration [2, 9, 15]. The alternative approach of postoperative endoscopic sphincterotomy, although usually effective, is not foolproof and may incur additional morbidity. Without question, fluorocholangiography is essential in the laparoscopic treatment of ductal calculi.

The argument for selective use of cholangiography during laparoscopic biliary surgery expressed by some [1] is flawed by several important considerations.

First, the important anomalies relating to the anatomy of the cystic-duct drainage are not identifiable by laparoscopic inspection of the structures in the triangle of Calot, and unsuspected calculi occur in macroscopically normal common bile ducts. Thus there are no persistently reliable intraoperative criteria upon which a selective policy can be based. In practice "a selective policy" means recourse to intraoperative cholangiography when the surgeon is in trouble. Second, a selective policy does not yield the necessary experience which enables quick cannulation and familiarity with interpretation of the cholangiographic findings. As a consequence, the surgeon who undertakes cholangiography occasionally is unlikely to be able to do it well and will never become attuned to the fine details of cholangiographic interpretation. Moreover, he will never progress to the stage when he can with safety and to the advantage of his patients manage ductal calculi laparoscopically.

In conclusion, this study has shown that intraoperative cholangiography imparts useful information in a small subset of patients undergoing laparoscopic cholecystectomy, which helps to minimize duct injuries and to detect unsuspected pathology. Its routine use is therefore strongly advocated. The procedure should be performed with modern, digitized, portable fluorocholangiographic units, which drastically reduce the procedure time and provide unparalleled exposure of the entire biliary tract in all the patients.

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