Is laparoscopic intraoperative cholangiogram a matter of routine?


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Abstract

Background: Intraoperative cholangiography during laparoscopic cholecystectomy reveals the anatomy of the biliary tree and any stones contained within it. The use of intraoperative cholangiography may be routine for all laparoscopic cholecystectomy. An alternative approach is a selective policy, performing intraoperative cholangiography only for those cases in which choledocholithiasis is suspected on clinical grounds, or those for which the anatomy appears unclear at operation. The literature pertaining to both approaches is reviewed, to delineate their respective merits.

Methods: Relevant articles in English were identified from the Medline database, and reviewed.

Results: The literature reviewed consisted of retrospective analyses. Overall the incidence of unsuspected retained stones was 4%, but only 15% of these would go on to cause clinical problems. The incidence of complete transection of the common bile duct was rare for both routine and selective intraoperative cholangiography policies, and did not differ between them. Rates of minor bile duct injury did not differ between groups, but was more likely to be recognized in the routine group than the selective (P = 0.01).

Conclusions: Routine intraoperative cholangiography yields very little useful clinical information over and above that which is obtained with selective policies. Large numbers of unnecessary intraoperative cholangiography are performed under routine intraoperative cholangiography policy, and therefore a selective policy is advocated. © 2004 Excerpta Medica, Inc. All rights reserved.

Keywords: Laparoscopic; Cholecystectomy; Cholangiogram; Choledocholithiasis; Biliary anatomy

Traditionally intraoperative cholangiography has been advocated as a routine procedure for all cholecystectomies, in order to accurately define the biliary anatomy and to detect intraductal stones [1–4].

The need for routine intraoperative cholangiography has been brought into question in cases where the surgical anatomy is clear at operation, as the majority of stones in the biliary tree may be suspected and detected preoperatively. The presentations suggesting the presence of stones in the common bile duct include acute pancreatitis and obstructive jaundice, whether clinical or biochemical. Ultrasonography [5] and intravenous cholangiography [6–8] may demonstrate biliary tract stones, and endoscopic retrograde cholangiopancreatography [9–14] and magnetic resonance cholangiopancreatography [11,12] demonstrate anatomy and filling defects in great detail. Intraoperative ultrasonography may also assist in defining the anatomy and excluding ductal stones [15–20].

Endoscopic retrograde cholangiopancreatography also constitutes a treatment modality for duct stones, by means of sphincterotomy and duct clearance [21]. Although this is not without the potential for serious complications [22,23] it obviates the need for open exploration of the common bile duct.

These options have driven a tendency toward performing intraoperative cholangiography only in selected cases, where there is reason to suspect common bile duct stones and endoscopic retrograde cholangiopancreatography is either not available or not possible. Difficulty in defining the anatomy with confidence at operation remains an indication for intraoperative cholangiography where selective policies are in operation.

This paper reviews the literature comparing the results of the policy of routine intraoperative cholangiography during laparoscopic cholecystectomy, and that of selective intraoperative cholangiography as above.
Table 1
Routine policy intraoperative cholangiography (IOC) for laparoscopic cholecystectomy (LC) where common bile duct (CBD) stones were not suspected on preoperative findings

<table>
<thead>
<tr>
<th>First author and reference number</th>
<th>Year</th>
<th>Number of LC with IOC (stones unsuspected)</th>
<th>Unsuspected CBD stones (%)</th>
<th>False positive IOC results (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snow [24]</td>
<td>2001</td>
<td>1517</td>
<td>42 (2.8)</td>
<td>5 (0.3)</td>
</tr>
<tr>
<td>Sabharwal [25]</td>
<td>1998</td>
<td>173</td>
<td>10 (5.8)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Stuart [26]</td>
<td>1998</td>
<td>384</td>
<td>17 (4.9)</td>
<td>2 (0.6)</td>
</tr>
<tr>
<td>Korman [27]</td>
<td>1996</td>
<td>61</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Duensing [28]</td>
<td>1995</td>
<td>236</td>
<td>25 (11)</td>
<td>9 (3.8)</td>
</tr>
<tr>
<td>Corbitt [29]</td>
<td>1994</td>
<td>511</td>
<td>29 (5.7)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Flowers [30]</td>
<td>1992</td>
<td>150</td>
<td>4 (2.7)</td>
<td>3 (2)</td>
</tr>
<tr>
<td>Pace [31]</td>
<td>1992</td>
<td>826</td>
<td>27 (3.3)</td>
<td>9 (1.1)</td>
</tr>
<tr>
<td>Corbitt [32]</td>
<td>1991</td>
<td>387</td>
<td>16 (4.1)</td>
<td>6 (1.6)</td>
</tr>
<tr>
<td>Total</td>
<td>—</td>
<td>4209</td>
<td>170 (4.0)</td>
<td>34 (0.8)</td>
</tr>
</tbody>
</table>

Methods

A Medline database search was undertaken to identify laparoscopic cholecystectomy series in which cholangiography was performed either on a routine or selective basis. The search period covered the whole era of laparoscopic cholecystectomy. The indications for cholangiography were noted in the series with selective policies. Data collected included the rate of detection of common bile duct stones, and the subsequent occurrence of symptomatic stones with documented clinical episodes of jaundice, cholangitis or pancreatitis. Also, the rates of major and minor common bile duct injury were recorded. For the purposes of this study a minor bile duct injury was one that was managed without choledochojejunostomy, and a major bile duct injury required choledochojejunostomy. The rate of successful performance of cholangiography as a proportion of those attempted was also noted.

The series for each policy were then subjected to meta-analysis, with the incidence of each complication calculated for each policy on cholangiography. Where a series did not report a particular complication, or did not define it accurately enough for valid comparison with other series, that series was excluded from meta-analysis of that particular complication, such that the rates of a particular complication could be reliably be compared between groups. Any caution necessary in interpreting the results were elaborated in the results.

Fisher’s exact test is used to make comparisons between groups, and $P < 0.05$ is deemed significant.

Results

Detection of common bile duct stones

In eight laparoscopic cholecystectomy series reported between 1991 and 2001 with a routine intraoperative cholangiography policy, 4,209 laparoscopic cholecystectomy were performed with intraoperative cholangiography on patients who were not suspected preoperatively to have common bile duct stones (Table 1) [24–32]. Of these 170 (4%) had common bile duct stones. This is consistent with previous reviews of the literature [33].

The rate of “false positive” intraoperative cholangiographies incorrectly suggesting common bile duct stones was 34 of 4,209 (0.8%). This rate is lower than reported in previous reviews, in which a false positive intraoperative cholangiography rate of 1.6% is reported. This may be due to improved quality of intraoperative cholangiography, with the introduction of radiolucent intraoperative cholangiography catheters, and real-time intraoperative cholangiography imaging with C-arm fluoroscopy in theater [34,35]. This reduction in false positive intraoperative cholangiography is encouraging, as it reduces the incidence of unnecessary interventions (bile duct exploration or endoscopic retrograde cholangiopancreatography).

When an intraoperative cholangiography suggests common bile duct stones, and none are found at subsequent endoscopic retrograde cholangiopancreatography, this may be due to false positive intraoperative cholangiography, or to spontaneous passage of common bile duct stone through the sphincter of Oddi in the interval between laparoscopic cholecystectomy and endoscopic retrograde cholangiopancreatography. This has been reported to occur in 25% of cases [36–38]. This highlights the point that not all retained stones will go on to cause clinical problems, although clearly when they occur, pancreatitis or ascending cholangitis in particular are potentially life-threatening.

In order to address more accurately what proportion of patients with common bile duct stones that were unsuspected clinically go on to cause clinical problems, nine series published between 1989 and 2001 of laparoscopic cholecystectomy with selective intraoperative cholangiography were reviewed (Table 2) [24,39–46]. A total of 5,179 laparoscopic cholecystectomy were performed without intraoperative cholangiography. There were no preoperative grounds to suspect common bile duct stones, specifically the patients had not suffered pancreatitis, been clinically or biochemically jaundiced, nor had common bile duct stones
Bile duct injuries are potentially serious complication of cholecystectomy [46], more common in laparoscopic than open procedures, and therefore it is important to explore the potential of routine intraoperative cholangiography to reduce their incidence.

Variations in biliary anatomy are so common, reported at 10% to 28% [48,49], that to call them anatomical anomalies is almost an oxymoron. This has often been cited as a justification for the routine use of intraoperative cholangiography during cholecystectomy [50–55], to reduce the incidence of bile duct injury. However, in the literature reviewed in this study and by others [56,57] there is no association between the occurrence of anomalous anatomy and bile duct injuries. Furthermore, anatomical variants of the biliary tree have been described that would not have been elucidated by intraoperative cholangiography, and therefore injury would not have been prevented [58,59]. It

Table 2
Selective policy laparoscopic cholecystectomy (LC) patients without intraoperative cholangiography (IOC), with subsequent symptomatic retained stones

<table>
<thead>
<tr>
<th>Author and reference number</th>
<th>Year</th>
<th>Number of LC without IOC</th>
<th>Residual stones later presenting symptomatically (%)</th>
<th>Follow-up (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snow [24]</td>
<td>2001</td>
<td>348</td>
<td>0 (0)</td>
<td>12–96</td>
</tr>
<tr>
<td>Silverstein [39]</td>
<td>1997</td>
<td>156</td>
<td>1 (0.6)</td>
<td>13</td>
</tr>
<tr>
<td>Jorgensen [40]</td>
<td>1996</td>
<td>307</td>
<td>1 (0.3)</td>
<td>12</td>
</tr>
<tr>
<td>Madhaven [41]</td>
<td>1995</td>
<td>319</td>
<td>6 (1.9)</td>
<td>24</td>
</tr>
<tr>
<td>Robinson [42]</td>
<td>1993</td>
<td>334</td>
<td>8 (2.4)</td>
<td>2</td>
</tr>
<tr>
<td>Grace [43]</td>
<td>1993</td>
<td>240</td>
<td>2 (0.8)</td>
<td>12</td>
</tr>
<tr>
<td>Pasquale [44]</td>
<td>1989</td>
<td>93</td>
<td>1 (1.1)</td>
<td>—</td>
</tr>
<tr>
<td>Taylor [45]</td>
<td>1995</td>
<td>2038</td>
<td>12 (0.6)</td>
<td>60</td>
</tr>
<tr>
<td>Dorazio [46]</td>
<td>1995</td>
<td>1344</td>
<td>1 (0.1)</td>
<td>6–42</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>5179</td>
<td>32 (0.6)</td>
<td>2–96</td>
</tr>
</tbody>
</table>

suggested on transabdominal ultrasound. Thirty-two patients (0.6%) proceeded to develop symptoms from residual stones. This is approximately double the rate reported in previous reviews [24,33]; however, these pertain largely to series of selective policy intraoperative cholangiography at open cholecystectomy, in which common bile duct stones may be palpated.

Thus it would appear that the true incidence of silent common bile duct stones at laparotomy is approximately 4%, but only in 0.6% do they go on to cause problems.

Overall, therefore, only 15% of patients with retained asymptomatic common bile duct stones will go on to develop problems from them. A possible explanation for this surprisingly low figure is that, as the stones had not manifested themselves in any way preoperatively, they were likely to be of a size that may pass relatively easily into the duodenum.

A note of caution in interpreting these series, however, relates to the duration of follow-up that is reported. Two years of follow-up would be ideal, as common bile duct stones presenting more than 2 years after cholecystectomy are conventionally accepted as having arisen de novo since cholecystectomy [47]. The range of follow-up durations in the studies reviewed was 2 months to 8 years.

However, as the 8-year follow-up series [24] claims to have a zero incidence of residual symptomatic common bile duct stones, and the 2-month series [42] has the highest reported rate of symptomatic stones at 2.4%, the concern over follow-up duration is unlikely to significantly distort the true rate of symptomatic stones.

Therefore, in order to detect one common bile duct stone that would go on to cause symptoms in a patient with no preoperative evidence of duct stones, 167 intraoperative cholangiograms would have to be performed during laparoscopic cholecystectomy, and 8 unnecessary bile duct explorations or endoscopic retrograde cholangiopancreatography would be needed (both for false negative intraoperative cholangiography and stones that would have remained asymptomatic).

This may be a conservative estimate, as another study [24] found twice as many unnecessary procedures would have to be performed to detect and remove one stone that would go on to be symptomatic. This difference is accounted for largely by the higher rate of symptomatic retained stones in this review compared with the previous report, as explained above.

In addition to these calculations comparing routine and selective intraoperative cholangiography, recent experience with laparoscopic ultrasound at laparoscopic cholecystectomy has suggested that this is a very sensitive test for retained common bile duct stones, without the same potential for common bile duct damage as placement of the intraoperative cholangiography cannula [15–20]. Ultrasoundography will not produce false positive results due to air introduced into the biliary tree. With increasing experience of the technique, it may be that it comes to replace cholangiography as it is safer and less likely to give false positive impressions of choledocholithiasis.

Overall, the literature reviewed would not appear to support the use of routine intraoperative cholangiography in laparoscopic cholecystectomy for the purpose of detecting and retrieving unsuspected common bile duct stones.

**Demonstration of biliary anatomy**

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has therefore been argued by proponents of the selective policy that meticulous dissection of Calot’s triangle with proper training is preferable to routine intraoperative cholangiography for the detection and management of anatomical variants [60,61]. If the anatomy is unclear then the placement of a cholangiogram catheter inadvertently directly into the common bile duct would cause a common bile duct injury, rather than avoid it, although complete transection would be avoided. The use of laparoscopic ultrasonography may clarify difficult anatomy without this risk.

Complete transection of the common bile duct is a serious injury requiring Roux-en-Y choledochojunostomy reconstruction, to prevent late biliary stenosis secondary to disruption of ductal blood supply. Therefore, although uncommon, complete transection is the most important bile duct injury to compare between groups. In 11 routine series between 1990 and 2001 (Table 3) [24–26,29,32,60,62–66] and 11 selective series between 1987 and 2001 (Table 4) [24,33,39–43,67–70] reviewed in this study, the incidence of common bile duct transection was 1 in 6,024 laparoscopic cholecystectomies (0.02%) with routine intraoperative cholangiography, and 3 in 3,268 (0.09%) without intraoperative cholangiography. These rates are not significantly different ($P = 0.13$, Fisher’s exact test).

Even where a true increase in rate of common bile duct transection without intraoperative cholangiography to be demonstrated with even larger numbers, selective policy proponents have argued that the increased risk of bile duct injury without intraoperative cholangiography indicates a failure to recognize a “difficult case” [70]. However, a selective intraoperative cholangiography policy will necessarily require a subjective judgement to be made, and therefore such “failures” of judgement are inherent in any selective policy and cannot be used to explain away increased risk.

In any event, the papers studied for this review demonstrate that if there is an increased risk of major bile duct injury without intraoperative cholangiography it is very small. All common bile duct transections were identified at the time of surgery, and none were reported after 1993.

Minor bile duct injury occurred in 0.28% of cases with

| Table 3 |
| Bile duct injuries in patients having intraoperative cholangiography (IOC) under routine policy |
| Author and reference number | Year | LC with IOC | Complete CBD transection (%) | Minor CBD injury (%) | Recognition at operation |
| Snow [24] | 2001 | 1517 | 0 (0) | 0 (0) | N/A |
| Stuart [26] | 1998 | 348 | 0 (0) | 2 (0.7) | N/A |
| Sabharwal [25] | 1998 | 173 | 0 (0) | 0 (0) | N/A |
| Kullman [60] | 1996 | 603 | 0 (0) | 3 (0.5) | 3 (0.5) |
| Traverso [62] | 1993 | 420 | 0 (0) | 2 (0.5) | 1 (0.25) |
| Corbitt [29] | 1994 | 511 | 0 (0) | 1 (0.2) | 1 (0.2) |
| Phillips [63] | 1990 | 645 | 0 (0) | 6 (0.9) | 6 (0.9) |
| Phillips [64] | 1992 | 855 | 0 (0) | 3 (0.4) | 3 (0.4) |
| Corbitt [32] | 1991 | 387 | 0 (0) | 0 (0) | N/A |
| Flowers [65] | 1991 | 150 | 0 (0) | 0 (0) | N/A |
| Berci [66] | 1990 | 415 | 1 (0.2) | 0 (0) | N/A |
| Total | — | 6024 | 1 (0.02) | 17 (0.28) | 14 (0.26) |

LC = laparoscopic cholecystectomy; CBD = common bile duct; N/A = not available.

| Table 4 |
| Bile duct injuries in patients having laparoscopic cholecystectomy (LC) without intraoperative cholangiography (IOC) |
| Author and reference number | Year | LC patients | Major CBD injury (%) | Minor CBD injury (%) | Immediate recognition |
| Snow [24] | 2001 | 348 | 0 | 0 | 0 |
| Silverstein [39] | 1997 | 156 | 0 | 0 | 0 |
| Jorgensen [40] | 1996 | 307 | 0 | 0 | 0 |
| Madhavan [41] | 1995 | 383 | 0 | 0 | 0 |
| Robinson [42] | 1995 | 334 | 0 | 0 | 0 |
| Lorimer [68] | 1994 | 525 | 0 | 0 | 0 |
| Grace [43] | 1992 | 229 | 0 | 2 | 2 |
| Barkun [69] | 1993 | 52 | 1 | 4 | 0 |
| Carlson [33] | 1993 | 134 | 0 | 0 | 0 |
| Lillemoe [70] | 1992 | 376 | 2 | 0 | 0 |
| Bogokowski [67] | 1987 | 343 | 0 | 0 | 0 |
| Total | — | 3268 | 3 (0.1) | 6 (0.18) | 2 (0.06) |

CBD = common bile duct.
routine intraoperative cholangiography, and 93% of these were recognized at the time of surgery. In the selective group of laparoscopic cholecystectomy not having intraoperative cholangiography, the rate of minor bile duct injury was 0.18%, of which 33% were recognized at the time. The rates of minor injury were not significantly different (P = 0.25, Fisher’s exact test), however, the immediate recognition of injury at operation was higher in the group having intraoperative cholangiography (P = 0.01, Fisher’s exact test). The immediate recognition of injury and appropriate management prevents significant morbidity and mortality [71,72], a point conceded even by advocates of selective cholangiography [69]. However, the numbers of patients that would benefit from immediate detection of a minor injury according to the literature reviewed is small; 821 routine intraoperative cholangiography would have to be picked up to prevent one minor injury going undetected.

**Technical proficiency performing intraoperative cholangiography**

Successful intraoperative cholangiography is achieved in 95% to 100% (Table 1) of cases done under a routine policy, and 75% to 100% of cases with a selective policy [33,68–70,73]. The lower end of the range for the selective policy may result from less frequent practice of the technique (and this explanation has been used to propose that routine intraoperative cholangiography should be used for training purposes [74]) or because some of the selective cases will be technically difficult precisely because of the indication for intraoperative cholangiography in the first place. It is not accepted that other surgical procedures should be performed purely for training purposes, and it is difficult to justify an exception to this for intraoperative cholangiography.

**Comments**

The principle indications for intraoperative cholangiography are the detection of common bile duct stones and the definition of biliary anatomy to reduce the incidence and severity of bile duct injury during laparoscopic cholecystectomy.

The literature reviewed suggests that very few extra common bile duct stones that will go on to cause problems will be detected by a routine intraoperative cholangiography policy compared with a selective policy where stones are suspected as a result of preoperative presentation or investigations.

No difference was found in the rates of major or minor bile duct injuries between the two policies, although injuries were more likely to be noted immediately if intraoperative cholangiography was performed.

It has been shown that large numbers of additional intraoperative cholangiography need to be performed under a routine policy compared with a selective policy either to detect extra problematic common bile duct stones, or diagnose promptly extra bile duct injuries.

The potential complications and cost of longer anesthesia times, radiation exposure, theater time, and contrast allergy may be significant under these circumstances. The financial cost just to diagnose one extra problematic common bile duct stone that was not suspected preoperatively has been calculated in another review to be half a million US dollars [24].

Therefore, it is the opinion of the authors that a selective policy of intraoperative cholangiography in laparoscopic cholecystectomy should be adopted.

**References**

[16] Catheline JM, Turner R, Rizik NM, et al. Evaluation of the biliary tree during laparoscopic cholecystectomy: laparoscopic ultrasound versus...


