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Choledochoscopy during biliary surgery for reducing the risk of overlooked stones

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Summary. Although cholangiography is routinely performed during biliary surgery to ensure the removal of all stones, it is not always successful. Some investigators have claimed that intraoperative choledochoscopy is more effective in detecting all stones, although reports on the efficacy of this method have been contradictory. Furthermore, no study has systematically examined either of these procedures in terms of the actual incidence of overlooked stones. Thus, to evaluate the merits of intraoperative cholangiography as opposed to choledochoscopy, we studied the incidence of overlooked bile duct stones after surgery. We investigated 126 patients who had undergone surgery during which choledocholithotomy was performed within the past 10 years; 117 of these cases involved common bile duct stones and 22, intrahepatic stones. After the exclusion of 13 subjects whose stones were deliberately left for postoperative treatment due to severe complications, 126 patients were finally analyzed. Overlooked stones were found postoperatively in 13 (10%) of these 126 subjects, including 11 (14%) of 63 patients who had been inspected by intraoperative cholangiography alone and 2 (3%) of 63 who had undergone both choledochoscopy and cholangiography during surgery. Therefore, the incidence of overlooked stones proved to be significantly lower in those who had undergone choledochoscopy combined with cholangiography ($P < 0.01$). Our results suggest the value of combining choledochoscopy with cholangiography during surgery for reducing the risk of overlooked bile duct stones.

Key words: Bile duct stones – Cholangiography – Choledochoscopy – Overlooked stones

During surgery for the removal of bile duct stones, overlooked stones have often been encountered postoperatively; thus, the use of intraoperative cholangiography is considered to be an important tool for stone detection. However, even when cholangiography is used, the postoperative incidence of undetected stones has been reported to range from 4% to 20% [4, 5, 7, 15]. Similarly, some reports have indicated a reduced incidence of overlooked stones through the use of intraoperative choledochoscopy [1, 10], although contradictory findings indicating an increased incidence have also been published [12]. These conflicting reports demonstrate the need for further evaluation of the value of choledochoscopy during surgical intervention. Thus, to study its usefulness in an attempt to reduce the incidence of stones that might be missed, we compared the results obtained in patients who had been examined by intraoperative cholangiography alone versus those obtained in subjects who had been examined by cholangiography in combination with choledochoscopy while undergoing surgery. Our results showed that patients who had undergone choledochoscopy along with cholangiography during surgery exhibited a lower incidence of retained stones, and this difference was statistically significant.

Patients and methods

Between 1981 and 1990, 477 patients were treated for bile duct stones (gallbladder stones, 338; common bile duct stones, 117; intrahepatic stones, 22). Of these subjects 139 who exhibited common bile duct or intrahepatic stones underwent choledocholithotomy. In all, 126 of these cases were checked postoperatively, the remaining 13 having been excluded because their stones were deliberately left for postoperative treatment due to severe complications (Table 1). The incidence of undetected stones was then compared between patients who had been examined

Table 1. Cases of gallstones

Disease	Cases	Stones deliberately left during surgery	No. of subjects studied
Gallbladder stones	338		
Common bile duct stones	117	7	110
Intrahepatic stones	22	6	16
Totals	477	13	126

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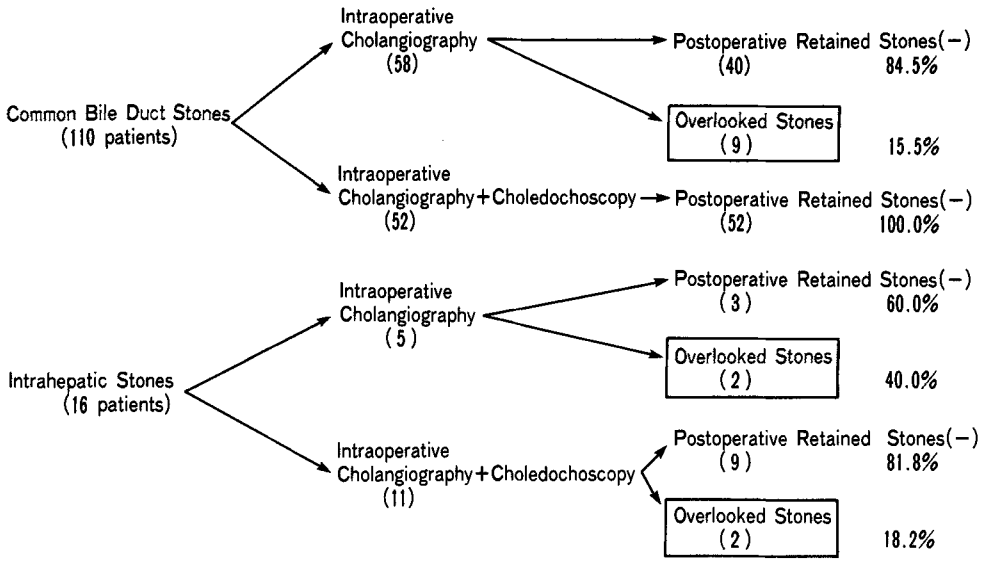

Fig. 1. Flow chart of patients exhibiting common bile duct or intrahepatic stones

Table 2. Patients exhibiting overlooked stones and the operative procedure they had undergone

Operative examination procedure	No. of patients	Postoperative stones detected (+)	Postoperative stones detected (−)	
Cholangiography	63	11	52	
Cholangiography and choledochoscopy	63	2	61	$P<0.01$
Totals	126	13	113	

during surgery solely by cholangiography and those who had been examined using choledochoscopy as well. The presence or absence of postsurgical stones was determined by postoperative choledochoscopy and selective cholangiography.

Results

Flow chart of patients exhibiting common bile duct or intrahepatic stones

A total of 110 subjects displaying common bile duct stones were evaluated as having been completely freed of their stones by lithotomy; 58 of these patients had been examined during surgery solely by cholangiography, whereas the remaining 52 had been examined using choledochoscopy as well. Among the former 58 cases, overlooked stones were found in 9 (16%) patients and were successfully removed with the aid of choledochoscopy in a subsequent operation. In the 52 cases who had been examined by both choledochoscopy and cholangiography during surgery, no further stones were found postoperatively.

Among the patients who had exhibited intrahepatic stones, 16 cases were evaluated as having been completely freed of their stones by lithotomy; 5 of these subjects had been examined solely by cholangiography during surgery, and 11 had been examined using cholangiography in combination with choledochoscopy. Overlooked stones were found in 2 (40%) of the former 5 cases and in 2 (18%) of the latter 11 cases (Fig. 1).

Overlooked stones

Overlooked stones were found by postoperative T-tube cholangiography and/or by choledochoscopy in 11 (17%) of 63 subjects who had been examined solely by cholangiography during surgery and in 2 (3%) of 63 patients who had been intraoperatively examined using cholangiography in combination with choledochoscopy (Table 2). Thus, the incidence of overlooked stones was significantly higher in the former group ($P<0.01$).

As evaluated retrospectively in 11 patients the possible reasons why stones were overlooked are listed in Table 3. In 13 subjects whose stones had remained undetected despite intraoperative cholangiography, the main reason was thought to be the small size of the stones. In nine of the subjects who exhibited extrahepatic bile duct stones, the stones had not been detected; in one case the stone had been mistaken for an air bubble and in another, for papillitis. Residual intrahepatic stones were also discovered in two patients, and another two cases of undetected stones seemed to reflect the technical difficulties of performing choledochoscopy during surgery.

It should be borne in mind that during surgery, selective choledochoscopy cannot always be carried out simultaneously with cholangiography since X-ray facilities are not usually available in the operating room. In the absence of X-ray films, it is quite possible that a small floating stone could be overlooked. In one case, a stone was detected postoperatively in a peripheral branch of the posterior lobe and was subsequently removed with the aid of choledochoscopy.

Discussion

The choledochoscope used in the present study is an improved version of Bakes' laryngoscope-like instrument that was originally developed and used in 1923 [2]. In 1937, Hollenberg and Einkner [9] reported the removal of gallbladder stones that had been found by means of an endoscope, and in 1953, Wildegans [16] developed a rigid

Table 3. Possible reasons why stone(s) were overlooked during the original surgical procedure

Case	Operative procedure	Operative examination	Site of overlooked stone(s)	Possible reasons for overlooking of stone(s)
1	Cholecystectomy T-tube	Cholangiography	Common bile duct	Small size of stone(s)
2	Cholecystectomy T-tube	Cholangiography	Common bile duct	Small size of stone(s)
3	Cholecystectomy T-tube	Cholangiography	Common bile duct	Small size of stone(s)
4	Cholecystectomy T-tube	Cholangiography	Common bile duct	Small size of stone(s)
5	Cholecystectomy T-tube	Cholangiography	Common bile duct	Small size of stone(s)
6	Cholecystectomy T-tube	Cholangiography	Common bile duct	Small size of stone(s)
7	Cholecystectomy T-tube	Cholangiography	Common bile duct	Small size of stone(s)
8	Cholecystectomy T-tube	Cholangiography	Common bile duct	Mistaken for papillitis
9	Cholecystectomy T-tube	Cholangiography	Common bile duct	Mistaken for an air bubble
10	Cholecystectomy T-tube	Cholangiography	Left intrahepatic bile duct	Small size of stone(s) and stenosis of left hepatic duct
11	Cholecystectomy T-tube	Cholangiography	Right and left intrahepatic ducts	Small size of stone(s) and stenosis of left hepatic duct
12	Cholecystectomy T-tube	Cholangiography and choledochoscopy	Right intrahepatic duct	Technical limit of the choledochoscopy
13	Cholecystectomy, hepaticojejunostomy	Cholangiography and choledochoscopy	Right and left intrahepatic ducts	Technical limit of the choledochoscopy

choledochoscope that rapidly gained wide acceptance [13]. In 1965, Shore and Lippman [14] developed a fiberscope for use in biliary surgery. Specifically, the choledochoscope that we used is an improved fiberscope model that was developed by Yamakawa et al. [17] and Gocho and Hiratsuka [8].

The advantages of using a fiberscope in biliary surgery have been reported by many investigators. Kappes et al. [11] have found a decreased incidence of overlooked stones (from 8% to 1.6%), which they attribute to the use of fiber-optic choledochoscopy. Furthermore, in a controlled study, Gartell and McGinn [6] have investigated the value of intraoperative choledochoscopy in preventing stones from being overlooked and described the superiority of the fiberscope to the rigid scope in terms of the simplicity of the procedure involved and the therapeutic results obtained. However, a further evaluation of the efficacy of choledochoscopy during surgical intervention seemed to be warranted because of contradictory claims. For instance, May and Corfield [12] found an increased incidence of overlooked stones (from 4% to 9%) in cases in which a fiber-optic choledochoscope had been used.

Similarly, the present study revealed that stones in the biliary tract had been overlooked in 13 of 126 patients exhibiting common bile duct or intrahepatic stones. However, the incidence was lower in subjects who had been examined by intraoperative choledochoscopy in combination with cholangiography (3%) than in those who had been examined using intraoperative cholangiography alone (17%, $P < 0.01$). These results suggest the usefulness of intraoperative choledochoscopy combined with cholangiography in reducing the risk of overlooked bile duct stones.

However, it should be emphasized that despite its effectiveness, choledochoscopy may not always enable the detection of all intrahepatic stones due to the limiting factors discussed below. To minimize the patient's risk and prevent contamination of the surgical field, the duration of a surgical procedure should not be unduly prolonged for the inclusion of choledochoscopy. Furthermore, a considerable amount of technical expertise is required of the endoscopist. In addition, the anatomical relationship or the distribution of the stones within the intrahepatic bile ducts are sometimes difficult to evaluate during surgery; as mentioned above, selective cholangiography can rarely be performed simultaneously with choledochoscopy because X-ray facilities are not always available in the operating room. Therefore, X-ray facilities located separately in most hospitals may represent the sole theater for postoperative choledochoscopy, only combined, selective cholangiography is possible. Under the latter circumstance, an overlooked stone was found in a patient despite the intraoperative use of both stone-detecting procedures.

It is probably best to avoid intraoperative choledochoscopy in subjects presenting severe complications such as acute cholangitis or obstructive jaundice, since the use of choledochoscopy may lead to endotoxemia. Therefore, the complete surgical removal of all stones during an operation cannot always be accomplished, and certain stones are sometimes deliberately left for postoperative choledochoscopic treatment so as to allow these severe complications to subside prior to complete stone removal [3, 18]. In the present study, 13 of 139 patients were postoperatively treated in this manner.

In the surgical removal of bile duct stones, the problem of overlooked stones persists, and the postoperative incidence of such stones has been reported to vary from 4% to 22% in cases in which cholangiography alone has been used [4, 5, 7, 15]. The present study revealed that choledochoscopy combined with cholangiography during surgery was more effective for stone removal than was cholangiography alone ($P < 0.01$). Thus, to decrease the number of overlooked stones, which are always painful for the patient, the combined use of these procedures is recommended during routine, biliary surgical intervention, provided that the surgeon is aware of their respective limitations.

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