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Management of Bile Duct Injuries and Strictures Following Cholecystectomy

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During 7057 conventional cholecystectomies (1972–1991), 16 bile duct injuries occurred, amounting to a risk of 0.22%. A total of 1022 laparoscopic cholecystectomies were performed without such a complication since April 1990. In a retrospective study, 64 patients (16 of our patients and 48 referrals) with an injury or stricture due to conventional cholecystectomy were investigated. In 14 of our 16 patients the injury was recognized and immediately repaired with a good long-term result of 93%, including one successful repair of a subsequent stricture. Two cases of unrecognized injury were managed by nonoperative means. The group of 48 referred patients comprised 10 early postoperative complications (21%) and 38 strictures after an "uneventful" cholecystectomy. Of the 64 total patients, 10 (16%) underwent nonoperative treatment, and 54 required surgery. The mean follow-up period after surgery was 7.4 ± 4.9 years. Most cases (93%) were repaired by bilioenteric anastomosis (i.e., foremost hepaticojejunostomy) with an 18% restricture rate. Including second and third repairs for restricture, a total of 60 operations (14 primary and 46 secondary reconstructions) were performed without hospital mortality. A good long-term result after stricture repair was achieved in 75% of the patients, whereas 17% had a poor outcome owing to restricture or death (10% had related mortality within 10 years). The other 8% had a moderate result due to recurrent cholangitis. Thus immediate repair of a bile duct injury offers the better chance of a favorable prognosis compared to secondary stricture repair.

The inherent risk of a bile duct injury during conventional cholecystectomy ranges from 0.1% to 0.2%. Laparoscopic cholecystectomy initially carried a high risk of more than 2% [1], the main risk factor probably being inexperience, as the risk has since dropped to less than 0.5%. On the basis of our experience, this paper is conceived as a contribution to the management of this awkward complication and its late sequelae, such as primary or anastomotic strictures.

Clinical Material

From 1972 through 1991, 7057 conventional cholecystectomies were performed. There were 16 complications, so the risk of bile duct injury amounted to 0.22%. From April 1990 to December 1992, 1022 laparoscopic cholecystectomies were carried out without such an injury. Intraoperative cholangiography was used selectively for both the conventional and laparoscopic approaches.

Including referred patients, 64 duct injuries or subsequent strictures following conventional cholecystectomy have been treated since 1972. In all cases, stone disease had been the indication for surgery. A follow-up study was performed in 1991 that included clinical examination, abdominal ultrasonography, and laboratory tests: blood sedimentation rate (BSR), white blood cell (WBC) count, transaminases (SGOT, SGPT), alkaline phosphatase, total bilirubin, prothrombin time). A telephone interview was conducted with the patient and the physician for those who would not consent to a clinical check-up. Fifty-nine patients (92%) were followed until July 1991 or until death (11 patients); 5 patients could not be traced. The mean follow-up period after operative treatment was 7.4 ± 4.9 years (range 6 months to 19 years). A good final outcome was assessed as absence of symptoms and normal liver function tests, whereas recurrent cholangitis was classified as a moderate result. Restricture and related death were assessed as treatment failure (i.e., poor result).

Patient Characteristics

A total of 40 women and 24 men were investigated. The mean age was 52 years (range 22–83 years). *Group A* (Table 1) consisted of our own 16 patients: 14 intraoperatively recognized injuries, 1 early postoperative complication, and 1 stricture due to unrecognized injuries. Perforation was caused by cystic duct cannulation ($n = 2$) and by use of the rigid choledochoscope ($n = 2$) or metal instruments ($n = 2$) during subsequent common duct exploration. Except for these perforations, complete transection was the most frequent injury (5 cases). The locations of the injuries were the cystic duct–common hepatic duct junction or further proximally ($n = 8$), distal common duct ($n = 7$), and anomalous right duct ($n = 1$).

Group B (Table 2) comprised 48 patients who had been referred from other hospitals, most of whom (46%) were suffering from an unrecognized injury. The early postoperative complications manifested by progressive jaundice between the 5th and 38th days in 10 patients (21%). Apart from that symptom, 4 patients had local septic complications: subhepatic abscess ($n = 2$), external biliary fistula ($n = 1$), and biliary

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Table 1. Group A: Our patients (1972–1991): conventional cholecystectomy.

Intraoperative injury	No. of pts.	Treatment	Result	Length of follow-up
Recognized				
Transection	3	End-to-end anastomosis	Good	5 mo,[a] 7 yr,[a] 14 yr
Wall defect/transection	3	Hepaticojejunostomy	Good 2/cholangitis 1	11 yr, 11 yr, 12 yr
Perforation	6 (2)	T Tube (+ papillotomy)	Good	2–16 yr[b]
Ligature	2	Removal/T tube	Good 1 Stricture 1 (good after two repairs)	3 yr 19 yr
Unrecognized				
Bilioma/injury of anomalous right duct	1	Percutaneous drainage/ nasobiliary drainage	Good	6 mo
Low stricture	1	Endoscopic dilatation	Good	2 yr
Total	16			
Good result			93%	
Moderate result			7%	

[a]Unrelated death.
[b]One patient was lost to follow-up after 3 years.

Table 2. Group B: referred patients (1972–1991): conventional cholecystectomy.

Previous operation	No. of pts.
One operation	
Unrecognized injury	22 (46%)
Cholecystectomy	18
Cholecystectomy + duct exploration	4
Recognized injury/immediate repair	9 (19%)
End-to-end anastomosis	6
Hepaticojejeunostomy (HJS)	1
Other	2
Two or three operations	17 (35%)
Duct reexploration	4
First stricture repair (HJS)	11 (9)
Second stricture repair (HJS)	2
Total	48 (100%)

Table 3. Site of stricture according to Bismuth's classification.

Stricture type	Description	No. of pts.
1	Low stricture (>2 cm CHD)	7 (15%)
2	Middle stricture (<2 cm CHD)	20 (42%)
3	High stricture (confluence preserved)	17 (35%)
4	High stricture (confluence destroyed)	3 (6%)
5	Right anomalous duct	1 (2%)

CHD: common hepatic duct stump.

peritonitis (n = 1). The injuries were caused by ligature (n = 5), transection between ligatures (n = 3), open transection (n = 1), or perforation (n = 1). Strictures due to an unrecognized injury became symptomatic as early as 2 months after an "uneventful" cholecystectomy, and most (70%) manifested within 2 years after operation. In 9 patients (19%), an unsuccessful attempt to repair the injury finally led to the stricture. Two or three previous operations—mainly failed repairs by hepaticojejunostomy (11 cases)—had been carried out in 17 patients (35%). According to Bismuth's [2] classification, middle strictures (type 2: 42%) were the most frequent, followed by high strictures with preserved confluence (type 3: 35%) (Table 3). Only one of the patients was found to have severe portal hypertension when reconstructive surgery was performed.

Operative Treatment

Intraoperatively recognized major injuries (6 patients) were repaired either by biliobiliary anastomosis (n = 3) or hepaticojejunostomy (n = 3) (Table 1). Instrumental perforations of the common duct (n = 6) were managed by external T-tube drainage with an additional transduodenal sphincteroplasty in two cases. Treatment of an inadvertent ligature of the common duct (n = 2) was confined to its immediate removal in combination with T-tube stenting. Regarding early postoperative complications, an inadvertent ligature with or without duct transection (8 cases) was managed by hepaticojejunostomy except for one case. Under local septic conditions, definite stricture repair was postponed 2 months in one case, whereas it was immediately carried out in two cases despite these adverse conditions.

Hepaticojejunostomy was the most frequent repair operation at this institution (Table 4). Type 2 strictures were repaired by the classic end-to-side anastomosis with a Roux-en-Y loop at least 40 cm long. Reconstruction of type 3 strictures was mainly accomplished by the Hepp-Couinaud type [3] hepaticojejunostomy (Fig. 1). For three type 4 strictures, hepaticojejeunostomy was performed either after reconstruction of the posterior wall of the confluence or by means of two separate anastomoses with both ducts. Since 1987, an access loop for percutaneous dilatation was added in 5 patients. A choledochoduodenostomy was applied in only 3 patients with a type 1 stricture. Before percutaneous or endoscopic dilatation became available, surgery had been confined in elderly high-risk patients to limited procedures such as transjejunal dilatation or plastic repair of minor anastomotic strictures (6 operations). Including five operations for restricture, the secondary repairs in our patients

Table 4. Secondary repair operations at surgical university clinic, Mannheim.

Type of repair	No. of operations	No. of recurrent strictures
First repair in our patients		
Bilioenteric anastomosis	38 (93%)	
Hepaticojejunostomy	24	6 (18%:6/33)[a]
Type Hepp-Couinaud (with access loop)	11 (5)	
Choledochoduodenostomy	3	1
Other	3 (7%)	
	41 (100%)	7
Second and third repair in our patients	5	
Hepaticojejunostomy	2	1
Transjejunal dilatation	3	1
Total	46 (group A 1 pt/group B 40 pts)	

[a]Two patients were not followed.

amounted to 46 operations in 41 patients. Regarding all repairs carried out at this and another institution, the 41 patients underwent a total of 68 operations: 18 patients (44%) had one repair and 20 patients (49%) had two repairs for restricture [three repairs in 2 patients (5%) and four repairs in 1 patient (2%)].

Operative Technique

A one-layer bilioenteric anastomosis with absorbable suture material (4-0/5-0 Vicryl or Maxon) is favored, placing the anterior suture row at the bile duct before the posterior side of the anastomosis is completely sutured. All effort is made to render the bile duct free of scar tissue in order to achieve precise mucosal approximation. With regard to transanastomotic splinting, an ideal wide anastomosis accomplished after repair of most type 1 or type 2 strictures would not be splinted. A high anastomosis would be splinted mainly for decompression by two transjejunal Voelker-type Silastic drains, which are removed 3 to 6 weeks later. An additional advantage is that radiologic control of the anastomosis is possible in case of a postoperative complication.

Nonoperative Treatment

Ten patients (16%) underwent nonoperative treatment, and one patient underwent surgery after an unsuccessful attempt at dilatation (Table 8). Endoscopic dilatation was performed in 2 patients with primary type 1 and 2 strictures (Fig. 2). Four patients (one primary and three anastomotic strictures) were managed by percutaneous dilatation (six dilatations and two stent implantations).

Results

Operative Treatment

There were 60 repair operations in 54 patients without *hospital mortality* but with high *morbidity* (28%) (Table 5). Surgical complications (23%) included 11.5% serious problems requiring relaparotomy. Among those surgical complications that could be managed conservatively was one external biliary fistula, representing the only anastomotic leak.

Regarding *late mortality*, there were five unrelated deaths and 4 patients died within 10 years from related causes after stricture repair (group B had 10% late mortality) (Table 6). Two women, 40 and 45 years old, respectively, succumbed to complications of secondary biliary cirrhosis despite patent hepaticojejunostomy. The survival curve for operated patients calculated by the Kaplan-Meier method showed a 5-year survival rate of 93.8% (SEM ± 3.4). Thus the probability of dying within 5 years due to an injury-related cause was estimated to be 6.2%.

In terms of the *long-term result*, all but one of our patients (group A) had a good final outcome (93%) after primary repair of the recognized injury (Table 7). One patient, who had developed a stricture only 3 months after removal of an inadvertent ligature, was finally cured by hepaticojejunostomy after the first repair by choledochoduodenostomy had failed. He has been free of symptoms for the past 18 years. The outcome was moderate in 1 patient, who suffers from occasional bouts of cholangitis 12 years after hepaticojejunostomy. After secondary repair (group B), a good final outcome was achieved in 75% of the patients, whereas 8% had a moderate result due to recurrent cholangitis (Table 7). A poor result was seen in 6 patients (17%) due to restricture or related death. The rate of recurrent stricture after hepaticojejunostomy was 18% in this group. Analyzing these six cases, it was found that three treatment failures could have been avoidable: There were two repairs of type 2 strictures by ill-advised side-to-side anastomosis and one repair of an open transection under local septic conditions on the 38th day that should have been delayed. Three restrictures occurred after difficult reconstruction of type 3 or 4 strictures, including one secondary repair and one patient with three previous duct explorations.

Nonoperative Treatment

There was one treatment failure after dilatation of an anastomotic stricture requiring surgery for definite repair (Table 8). One of our patients had a postoperative complication that was successfully managed by nonsurgical means (Fig. 3). Two patients with radiologically distinct strictures, who are clinically almost free of symptoms, have been under observation for 36 and 39 months without signs of progressive disease. One of these patients had refused the proposed repair operation. A referred patient with an early stricture whose definite repair had been delayed owing to an external biliary fistula died only 2 months after cholecystectomy from a ruptured false aneurysm of the hepatic artery despite an emergency laparotomy.

Discussion

Sixteen duct injuries occurred in this series of more than 7000 conventional cholecystectomies, amounting to a risk of 0.22%. The 93% good final outcome with a mean follow-up of more than 7 years is mainly attributed to the fact that most injuries were recognized and immediately repaired. This result confirms another report [4] that primary repair is an important factor with regard to a good long-term prognosis. It compares favorably

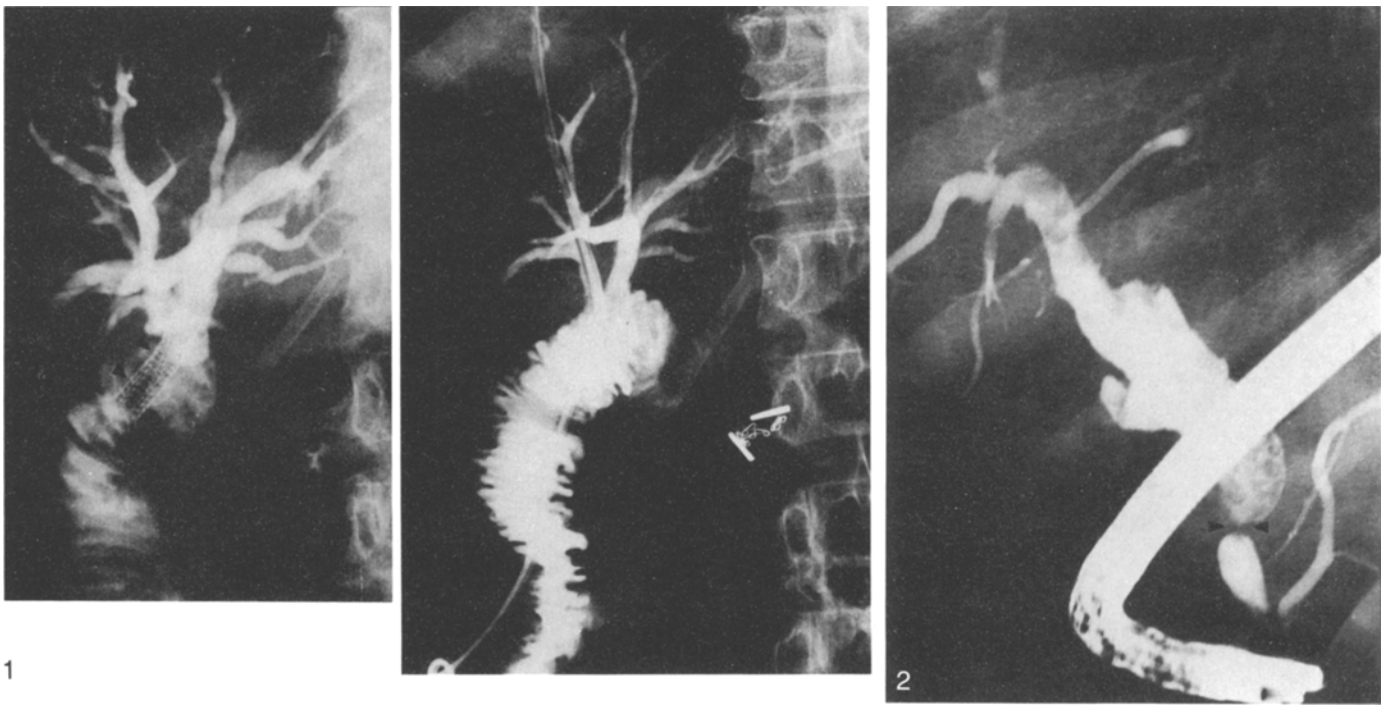

Fig. 1. Anastomotic stricture of a hepaticojejunostomy 15 years after hepatic duct transection. Treatment by percutaneous dilatation and implantation of a balloon expandable metallic stent was unsuccessful. Percutaneous cholangiography was done 8 months later. **Left.** Dilated intrahepatic duct system due to subtotal stent occlusion (arrowheads). Secondary repair by Hepp-Couinaud type hepaticojejunostomy with clip-marked access loop. **Right.** Cholangiography via injection of a Voelker drain shows the wide anastomosis.

Fig. 2. An 83-year-old man had a symptomatic stricture 16 years after common duct exploration complicated by a biliary fistula. Endoscopic retrograde cholangiography shows a short, low, common duct stricture (arrowheads) with prestenotic dilation and multiple stones. Treatment by endoscopic sphincterotomy and four consecutive dilatations with removal of stones was successful. The patient has been in good health for the past 2 years without signs of restricture.

Table 5. Postoperative mortality and morbidity: groups A and B.

	Group A (n = 14 pts/ 16 ops)	Group B (n = 40 pts/ 44 ops)	Total
Hospital mortality	0	0	
Morbidity			28%
Medical complications			5%
Surgical complication	12%	27%	23%
Conservative treatment			
Biliary fistula	0	1	
Hepaticolithiasis	0	3	
Wound infection	1	2	
Total	1 (6%)	6 (13.5%)	
Relaparotomy			
Hemorrhage	0	4	
Bowel obstruction	0	1	
Subhepatic abscess	0	1	
Lost Voelker drain	1	0	
Total	1 (6%)	6 (13.5%)	

with the poor result reported by Andren-Sandberg et al. [5] despite primary repair, which may be explained by its being part of a multicenter study (65 cases from 51 hospitals).

Intraoperative Injury

Instrumental perforation of the common duct, even when located in the retropancreatic part, is safely managed by T-tube drainage. An additional transduodenal sphincteroplasty is required only if any doubt remains about the patency of the papilla of Vater, which must be ascertained by cholangiography. In case of an *inadvertent duct ligature*, it is worth attempting simply to remove the ligature and not to resect the affected site, which should be stented. One must realize, however, that a stricture might develop, as occurred in one of our cases within only 3 months. A partial transection or small wall defect may be repaired by direct suture over a T-tube. For a *major wall defect*, even if it is not circumferential, one should opt for repair by hepaticojejunostomy. Blumgart [6] proposed use of the serosal patch-plasty with a Roux-en-Y jejunal loop for repair of a long lateral but incomplete defect (it may be useful in the odd case).

Clear-cut *complete duct transection*, the most frequent major injury [5, 7], is the only indication for an end-to-end anastomosis. A Kocher maneuver must be performed to accomplish a tension-free anastomosis, which is stented by a separately inserted T-tube. Several factors would render reconstruction by end-to-end anastomosis inadequate: (1) any loss of length; (2) high location of the injury near the hilus; and (3) small-caliber duct with a diameter of less than 0.6 to 0.7 cm (i.e., less than the

Table 6. Late mortality after operative treatment: groups A and B.

Cause of death	Group A (n = 14)	Group B (n = 40)	Length of survival
Related death			
Biliary cirrhosis (liver failure/variceal bleeding)	0	3 (2nd repair all)	14 mo, 33 mo, 9 yr
Septic shock (restricture/cholangitis)	0	1 (1st repair)	6 mo
Total		4 (10%)	
Unrelated death			
Myocardial infarction	0	1	14 mo
Apoplectic insult	0	1	2 yr
Gastric carcinoma	1	0	7 yr
Pancreatic carcinoma	1	1	5 mo, 4 yr
Total	2	7	

Table 7. Result of operative treatment: immediate (group A) versus stricture repair (group B).

Treatment	Result (no. of pts.) Good	Moderate (cholangitis)	Poor Stricture	Related death
Group A				
Immediate repair	12	1	1[a]	0
Late repair	1[a]	0	0	0
Σ (n = 14 pts)	13	1	0	0
	93%	7%		
Group B				
First own repair	26	2	4 (3[a])	4 (2 strictures)
Second and third repair[a]	1	1	1	0
Σ (n = 36 pts)[b]	27	3	2	4
	75%	8%	17%	

[a]Reoperation in our clinic.
[b]Four patients were not followed.

Table 8. Nonoperative treatment.

Management	No. of pts.	Result	Length of follow-up
Endoscopic dilatation/ endoprosthesis	2	Good	6 mo, 2 yr
Percutaneous dilatation/ stenting	3 (+1)	2 Good	1 and 4 yr
		1 Stricture	8 mo later operation
		1 Suicide	10 mo
Percutaneous and nasobiliary drainage	1	Good	6 mo
Observation/antibiotics	4	3 Good	3–5 yr
		1 Death[a]	2 mo
Total	10 (+1)		

[a]Ruptured aneurysm of hepatic artery.

mean normal diameter). Hence repair by an end-to-side Roux-en-Y hepaticojejunostomy is technically easier and safer under those adverse circumstances. The unfavorable result after primary injury repair reported by Csendes et al. [7] may be due to rather liberal use of the end-to-end anastomosis.

Early Postoperative Complication

The patients (1 of ours and 10 referrals) presented between the first and sixth weeks after operation with jaundice, bile leakage manifesting by an external or internal fistula, or both. Such leakage would result in a local subhepatic bilioma or diffuse biliary peritonitis. One must be aware of the fact that any such bile leak carries the risk of septic complications.

According to our experience, *progressive jaundice* (Fig. 4) without signs of biliary sepsis developing toward the second postoperative week is highly suspicious of an inadvertent ligature with or without transection. After establishing the diagnosis by endoscopic or percutaneous cholangiography, showing complete obstruction without leakage, immediate relaparotomy should be undertaken. Repair was routinely performed by end-to-side hepaticojejunostomy after removing the ligature. Being well aware of the risk of restricture, the delayed attempt at simply removing a ligature may be worthwhile in the odd high-risk patient (Fig. 4).

Two of five patients with *biliary leakage* formerly underwent a one-stage procedure with immediate repair under local septic conditions. One of them had a complicated postoperative course that required three relaparotomies, and the other one developed another stricture within 1 year. The policy was then changed toward a more conservative procedure, recommended for instance by Czerniak et al. [8].

Management of any biliary fistula should be based on two principles: (1) primary control of the leak by nonoperative means; and (2) delay of definite stricture repair. Apart from antibiotic coverage, this treatment comprises percutaneous drainage of abdominal collections (bilioma or abscess) and decompression of the bile duct system either by an endoscopic procedure (nasobiliary tube or endoprosthesis) or percutaneous transhepatic drainage for diversion of bile from the leak [9–11]. There are two situations rendering early relaparotomy unavoidable: (1) failure of conservative treatment; and (2) diffuse biliary peritonitis requiring extensive lavage and drainage of the abdominal cavity and, if technically feasible, control of the leak by inserting a tube into the bile duct for external drainage. Early relaparotomy for control of biliary sepsis should not be combined with an attempt at definite repair, as morbidity including the risk of restricture is markedly increased owing to the adverse local conditions.

Some fistulas close completely under nonoperative treatment

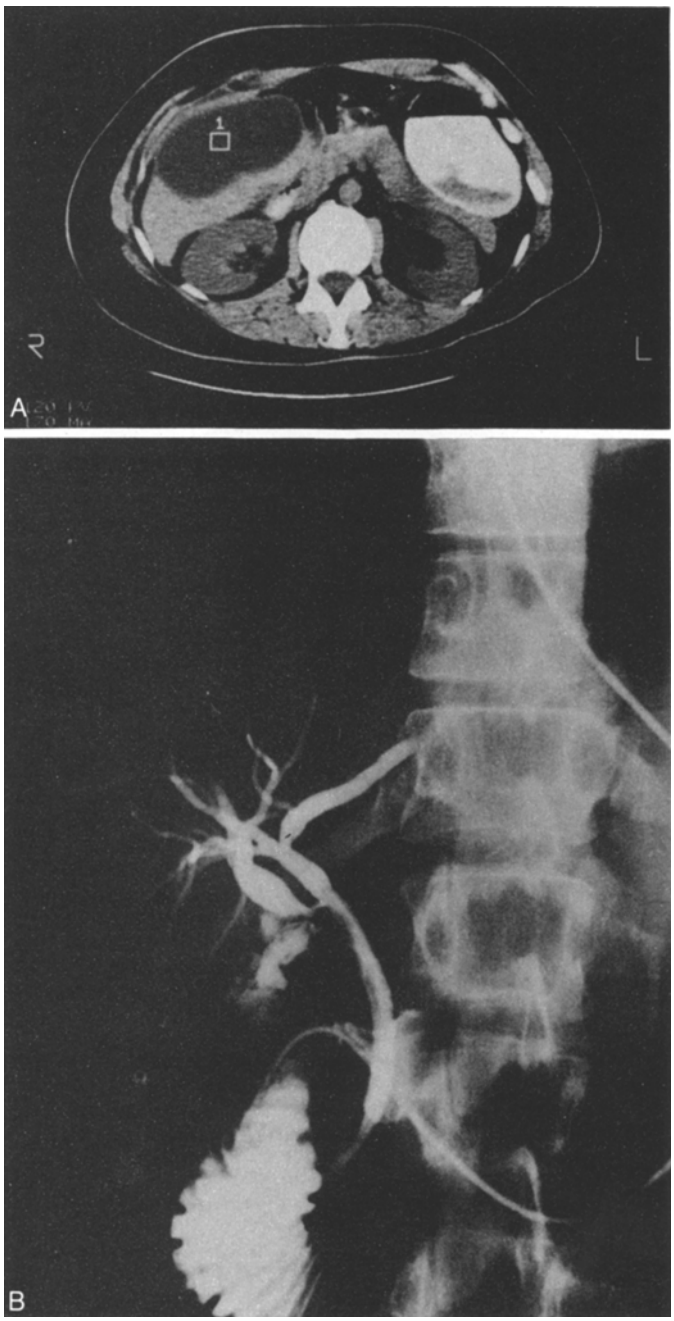

Fig. 3. Unrecognized injury of an anomalous right duct during an "uneventful" cholecystectomy with onset of pain in the right upper quadrant 9 days later. **A.** CT scan shows a perihepatic fluid collection (bilioma) successfully treated by ultrasound-guided percutaneous drainage. The bile duct system was decompressed using a nasobiliary tube. **B.** Cholangiography, by injecting the tube, shows bile leakage (arrow) from the injured duct with prestenotic dilation. Patient was symptom-free with normal liver function tests 6 months after operation.

and do not require surgery at all [9, 10]. Being aware of the potential development of an incomplete stricture, such a patient must be kept under long-term control. If the healing process resulted in a complete stricture manifesting with jaundice or cholangitis, definite repair should not be delayed any longer. Czerniak et al. [8] reported a range of 7 to 10 months after initial injury to operation. Repair may be carried out earlier provided the proximal bile duct system has become significantly dilated ($\phi > 1$ cm), and at least 3 months should have passed for subsidence of local inflammation.

In addition to the common duct, the right hepatic or an anomalous right duct are occasionally affected by an injury (Fig. 5). As Longmire and Tompkins [12] pointed out, "bland obstruction without infection is remarkably well tolerated." In contrast, partial occlusion by an incomplete stricture may lead to infection from cholangitis. Hence a small-caliber duct should be ligated but not repaired even if the injury is recognized intraoperatively [12, 13]. This procedure can be adequate even in case of an injury to a small right hepatic duct as its repair with unpredictable outcome may be more hazardous than its ligation. Urgent treatment is required only if such a patient presents with signs of infection. A drainage procedure must be performed, but even liver resection for a chronic abscess may be necessary [12, 14].

Late Stricture

Most primary or anastomotic strictures (65–85%) present within 2 years after initial surgery, but occasionally their development takes 10 years or even more (5–10%) [15, 16]. The surgeon concerned with their treatment must answer three questions.

1. *Observation or operation?* An obvious indication for a repair operation is the deeply jaundiced patient who presents with a dilated duct system caused by a complete stricture. It is not uncommon, however, that a patient merely suffers from occasional bouts of mild cholangitis in combination with transient elevation of the alkaline phosphatase level, although the cholangiogram shows a high-grade stricture. Apart from the result of a HIDA scan, the extent of duct dilatation can be measured in terms of the functional relevance of the stricture. An adequate assessment depends on the surgeon's personal experience, and he or she should not yield to the temptation "to treat x-rays," as Blumgart [6] put it. The decision for or against surgical treatment is based on the clinical symptoms, liver function tests, and cholangiography. Severe bouts of cholangitis over short intervals and a steadily increasing alkaline phosphatase level indicate that the operation should not be postponed.
2. *Dilatation or operation?* Among 64 patients, 6 (9%) were treated either by endoscopic ($n = 2$) or percutaneous ($n = 4$) dilatation. Endoscopic dilatation with or without endoprosthetic stenting, mainly applicable to primary type 1 and 2 stricture, has the advantage of being associated with low morbidity [17, 18]. Performed by an experienced endoscopist, the procedure has a success rate ranging from 85% to 95%. In contrast, percutaneous dilatation applicable also to high anastomotic strictures, is associated with considerable morbidity (up to 30%), mainly due to severe bleeding and septic complications [19–21]. The disadvantage of both methods is that frequently procedures must be repeated to accomplish a primary success. In terms of long-term results, the reported follow-up periods of both endoscopic and percutaneous dilatation are too short for final assessment. A study reported by Pitt et al. [21] from Johns Hopkins Hospital evaluated surgery compared percutaneous dilata-

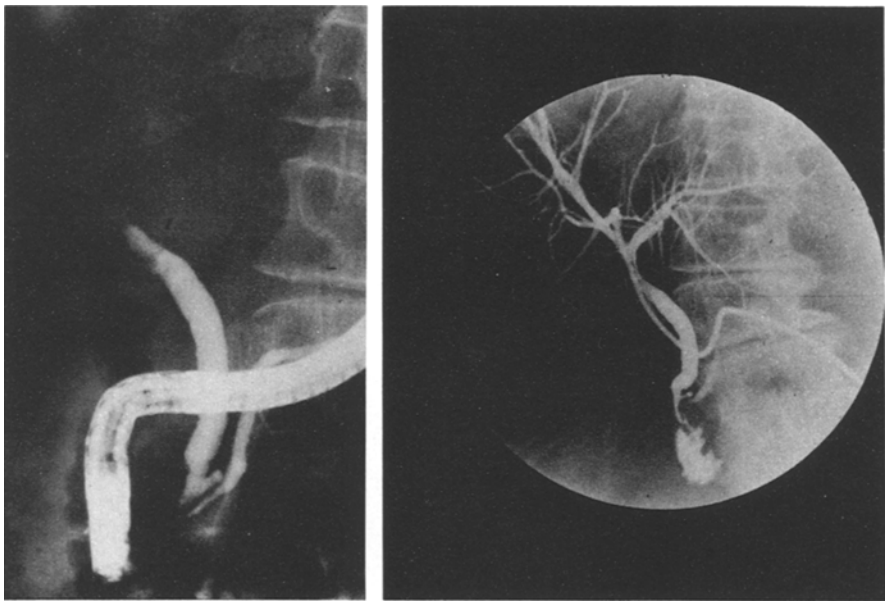

Fig. 4. A 79-year-old woman had progressive jaundice after an "uneventful" cholecystectomy. **Left.** Endoscopic retrograde cholangiography shows complete occlusion of the hepatic duct proximal to the cystic duct stump. At relaparotomy 8 days later a single ligature was removed and a Y-tube inserted and left in place for 6 months. **Right.** Postoperative cholangiography by injection of the Y-tube shows a normal bile duct system without intrahepatic dilation. The patient was in good health without signs of stricture until 5 years later, when she was lost to follow-up.

tion groups (25 versus 20 patients). The long-term result of surgery was significantly better than that of dilatation (88% versus 55%); the restricture rate after surgery was 12%, whereas 45% of the patients treated by dilatation developed a restricture within 36 months. Although hospital mortality was zero in both groups, the morbidity was lower in the surgery group (20% versus 35%). Thus dilatation should be confined to elderly high-risk patients or those not consenting to an operation. Furthermore, dilatation should be considered in patients in whom operation is contraindicated because of portal hypertension or more than two previous repair operations. In agreement with the interventional radiologist and the endoscopist, apart from the exceptions already stated, the policy at our institution is that surgery is the primary treatment of a late stricture.

3. *Operation—but which one?* For reconstruction of a late stricture, bilioenteric anastomosis (92.5%) was favored in our series; biliobiliary anastomosis was never used. There is general consensus among surgeons that stricture repair by biliobiliary anastomosis should be avoided owing to the inferior long-term result [2, 6, 15, 16]. Repair of type 1 or 2 strictures was routinely achieved by the classic end-to-side Roux-en-Y hepaticojejeunostomy, which is preferred to choledochojejunostomy assuming that the high anastomosis is less vulnerable to ischemic damage with subsequent restricture, as reported by Terblanche et al. [22]. Choledochoduodenostomy for repair of a low stricture was limited to three cases with pronounced dilatation of the common duct, exceeding 1 cm in diameter. For type 3 strictures, the Hepp-Couinaud type hepaticojejeunostomy with the longest possible side-to-side anastomosis to the left duct is favored. Even with type 4 strictures managed by reconstruction of the posterior wall of the confluence or by two separate anastomoses, we never felt compelled to adopt the mucosal graft technique. When the risk of restricture seemed to be increased, a closed access loop for percutaneous transjejunal dilatation was added [23, 24]. Since 1987, long-term stenting to prevent restricture has been completely abandoned at our institution in favor of the access loop. Yet it is still an open question if the access loop is an adequate answer to the problem of managing an impending restricture.

Although all repair operations could be performed without hospital mortality, the morbidity amounted to 28% including 11.5% serious surgical complications that required relaparotomy. According to the literature of the last decade, mortality should not exceed 5% (0–4% range) [2, 6, 15, 21, 25]. However, most authors reported on similarly high morbidity rates, ranging between 10% and 30%. The rate of recurrent stricture after hepaticojejeunostomy was 18%. A critical analysis of these treatment failures revealed that half of them possibly could have been avoided if the strictures had been managed according to present criteria. Generally, the recurrence rate ranges from 10% to 20%, although it is as high as 25% after second repairs [15, 21, 25]. It is the number of previous repairs that greatly influences the result of treatment (in addition to the stricture location) [16, 26]. A second repair operation may be feasible, but for high strictures the limit of successful surgical management is probably reached with the third repair. This conclusion had been drawn by Warren and Jefferson [27] in 1973 based on a large series at the Lahey Clinic. Including second and third repairs, 75% of our referred patients with an early postoperative complication or late stricture had a good long-term outcome after operative treatment with a mean follow-up of 7.4 years. A poor treatment result was observed in 17% of these patients, with an injury-related late mortality of 10% within 10 years. Thus primary repair of recognized injuries among our patients resulted in 93% good long-term outcome, clearly providing a better prognosis.

Laparoscopic Cholecystectomy

The series of 1022 laparoscopic cholecystectomies without bile duct injury proves that this procedure can be as safe as the

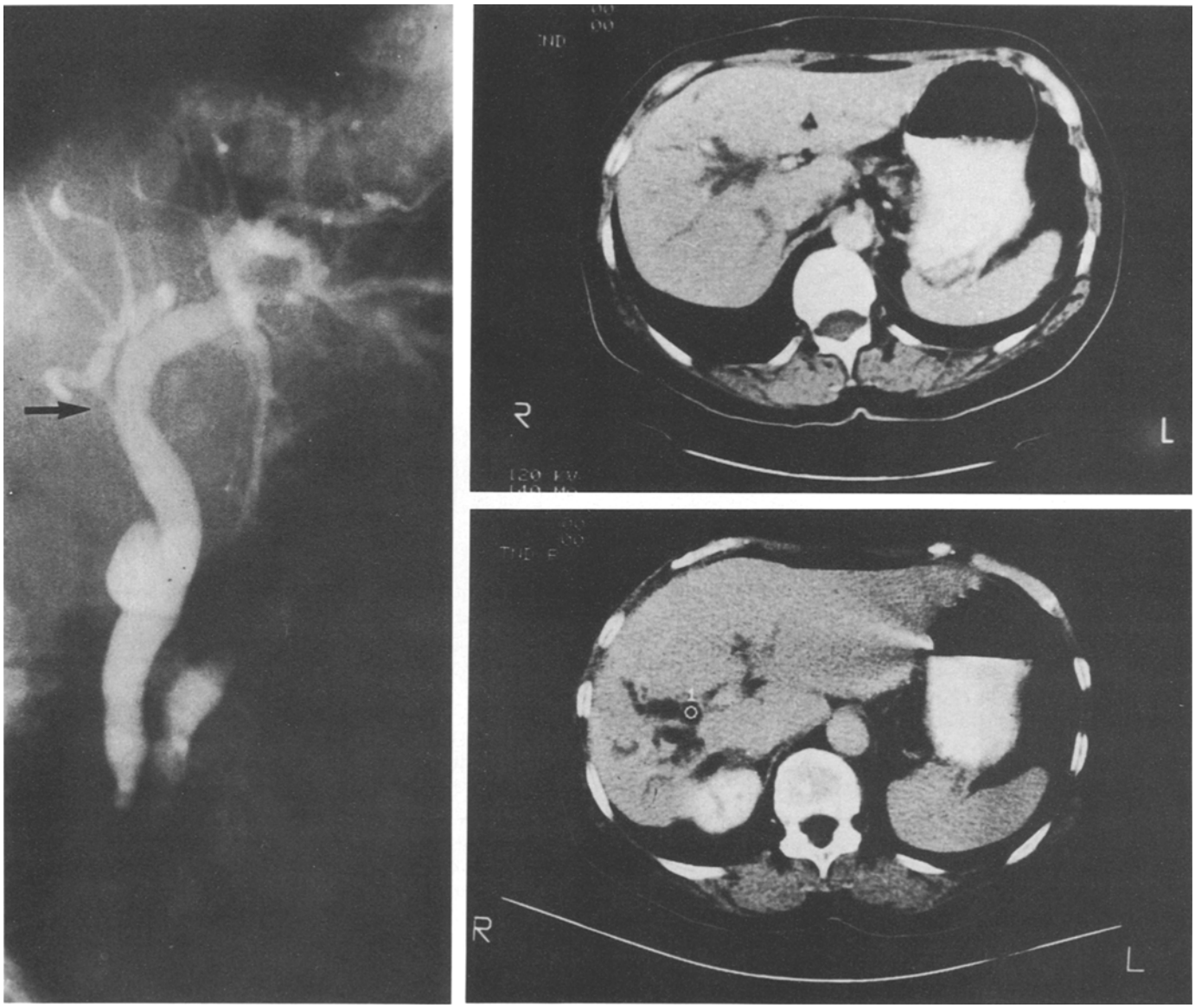

Fig. 5. Inadvertent ligature with transection of the right duct. The patient was referred 4 weeks after cholecystectomy with abdominal pain and pathologic liver function tests of cholestatic pattern (alkaline phosphatase 1400 U/L). **Left.** Endoscopic cholangiography revealed complete occlusion of the right duct (arrow) without bile leakage. **Top right.** CT scan shows dilated bile ducts in the right hepatic lobe. **Bottom right.** Follow-up CT scan 3 years later shows atrophy of the right lobe with persistent bile duct dilation and hypertrophy of the left lobe. The patient was symptom-free with near-normal liver function tests (alkaline phosphatase 190–250 U/L) 5 years after operation.

conventional operation regarding its main complication. There were four cases of bile leakage from the cystic stump or liver bed, unrelated to a duct injury (three postoperative biliomas successfully managed by percutaneous drainage and one case of biliary peritonitis requiring laparotomy). Thus our experience with management of duct injuries during laparoscopic cholecystectomy is limited to two cases only recently referred from another hospital and not included in this report. With the conventional operation, most injuries are not discovered during surgery [28–30]. Even if the injury is recognized intraoperatively, it is difficult to avoid conversion to an open repair operation. An exception is an obvious minor injury of the common duct suitable for laparoscopic T-tube insertion [31] or direct suture closure combined with subsequent endoscopic stenting. Certainly it is true in most cases that "the principles of management of injuries sustained during laparoscopic cholecystectomy are essentially the same as for those sustained during open procedures" [28].

Résumé

Parmi 7057 cholécystectomies traditionnelles réalisées entre 1972 et 1991, on a enregistré 16 lésions de la voie biliaire principale, ce qui représente un risque de 0.22%. Depuis le mois

d'avril 1990, on a réalisé 1022 cholécystectomies sous coelioscopie, sans observer un seul de ces accidents. Nous avons analysé rétrospectivement les dossiers de 64 patients ayant une lésion ou une sténose secondaire à une cholécystectomie traditionnelle. Chez 14 de ces 16 observations personnelles, la lésion a été reconnue pendant l'intervention et a été réparée immédiatement avec un résultat à long terme satisfaisant chez 93% de ces patients; un de ces patients a dû être opéré deux fois. Chez deux patients ayant une lésion non reconnue pendant l'intervention, le traitement a été conservateur. Parmi les 48 patients vus en seconde main, il y avait 10 patients ayant une lésion récente, apparue dans les suites immédiates d'une intervention (21%) et 38 sténoses apparues dans les suites d'une cholécystectomie "non compliquée". Seulement 10 patients (16%) ont été traités de facon conservatrice alors que 54 patients ont nécessité une réparation chirurgicale. Le suivi moyen a été de 7.4 ± 4.9 ans. La plupart des cas (93%) ont été réparés par une anastomose bilio-intestinale, le plus souvent des anastomoses hépatico-jéjunales, avec un taux de resténose de 18%. En incluant les réparations secondaires et tertiaires, un total de 60 interventions (14 reconstructions primitives et 46 reconstructions secondaires) ont été pratiquées, sans aucune mortalité. Les résultats à long terme après réparation biliaire étaient considérés comme des succès chez 75% des patients, alors que 17% des patients ont eu des suites compliquées de resténose ou mort (10% de mortalité en 10 ans). Ainsi, la réparation immédiate des lésions de la voie biliaire offre un bien meilleur pronostic que les réparations secondaires.

Resumen

Se presentaron 16 lesiones de la vía biliar en 7.057 colecistectomías (1972–1991), lo cual significa un riesgo de 0.22%. Desde Abril de 1990 se han practicado 1.022 colecistectomías laparoscópicas sin que se haya prsentado tal complicación.

En un estudio retrospectivo se estudiaron 64 pacientes con lesión o estenosis debido a colecistectomía convencional. En 14 de 16 la lesión fue reconocida y reparada inmediatamente con un buen resultado a largo plazo en 93%, incluyendo una exitosa reparación de una estrechez subsiguiente. Dos casos propios de lesión no reconocida fueron manejados por medios no operatorios. El grupo de 48 pacientes referidos estuvo conformado por 10 casos de complicaciones postoperatorias tempranas (21%) y 38 estrecheces luego de colecistectomía hecha "sin complicaciones". Diez pacientes (16%) fueron tratados por medios no operatorios y 54 requirieron cirugía. El promedio de seguimiento después de la cirugía fue de 7.4 ± 4.9 años. La mayoría de los casos (93%) fueron reparados mediante anastomosis bilioentérica, principalmente hepaticoyeyunostomía con una tasa de reestenosis de 18%. Incluyendo segundas y terceras reparaciones por estenosis, se realizaron 60 operaciones (14 reconstrucciones primarias y 46 secundarias) sin mortalidad hospitalaria. Se logró un buen resultado a largo plazo en 75% de los pacientes con reparaciones por estenosis y 17 pacientes exhibieron mal resultado, a juzgar por reestenosis o por muerte (10% mortalidad en 10 años). Por lo tanto, aparece obvio que la reparación inmediata de una lesión de la vía biliar ofrece la mejor oportunidad de un pronóstico favorable en comparación con la reparación secundaria de una estrechez.

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Invited Commentary

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Injuries of the common bile duct can be classified as spontaneous (as in the Mirizzi syndrome types II–IV or cholecistobiliary fistulas [1]) and iatrogenic, (accidental section, instrumental perforations, tears, suture and ligature of the bile duct [2, 3]). In their excellent study concerning the management of bile duct injuries and strictures following cholecystectomy, Raute et al review results gathered over a 20-year period, from, among others, 16 of their own patients (0.22% occurrence) and 48 referred cases. We have had similar results [1, 3]: In a 15-year period, having operated on 16,500 cases with benign biliary disease, we have had 18 accidental sections, 20 distal perforations, 17 cases with tears, and 4 ligatures or sutures of the common bile duct (0.36% occurrence). We agree with Raute that the best occasion to repair bile duct injuries is during the same operation in which they occur. The use of operative cholangiography does not prevent their occurrence. It is reported here that if the accidental section of the common bile duct is repaired immediately, late results are good. End-to-end anastomosis performed according to the indications defined by the authors is the preferred technique. But the precise details regarding types of sutures, stenting or not, length of its use, etc. have not been provided. If it is not possible to perform end-to-end anastomosis, hepaticojejunostomy should be employed. Perforations by instruments are best managed by suture and T-tube for decompression. The authors were lucky to identify 2 cases with ligatures and repair them immediately; this is the complication that is usually inadvertent. The follow-up period reported is short in some patients and the authors will have to wait a while longer for definitive conclusions.

The results are quite different when referred patients are treated, because they come to the hospital either with progressive jaundice or septic complications secondary to internal or external biliary fistula, with an established stricture [2, 4]. We also agree that it is important to determine the precise location of the stricture according to Bismuth [4], because there is a good correlation between operative alternatives and late results [4]. We also agree with the surgical techniques employed for patients with strictures type II and III. Stenting should be employed only in patients with strictures type III and IV. A point of disagreement is in the length of their use. We prefer to implement stents for several months rather than for only 3–6 weeks. Though the authors had no operative mortality, which is quite exceptional considering the severity of the disease, there is a high rate of complications that clearly demonstrates the serious nature of the disease. When describing the late results of operative treatment in Table 7, the authors should have expressed more clearly the relation between the type of stricture and final outcome. The results of nonoperative treatment with endoscopic or percutaneous dilatation must be interpreted very carefully. These techniques should be employed only in strictures type I and II, and my personal belief is that they are only a paliative treatment and surgery is the final definitive corrective procedure. Though the follow-up of all these patients is very short, already one out of five cases required an operation. In terms of operative mortality, the actual good results of surgery described in this study, support even more strongly the surgical approach.

We agree with all the authors' comments in respect to the general management of biliary injuries. The best time period for definitive repair after any injury is any time during the 4 months following its occurrence.

In summary, this excellent report provides very important information for all surgeons dedicated to upper digestive tract surgery. It is difficult to find reports concerning the treatment of early injuries of the bile duct, while there are many reports concerning the treatment of an established stricture. We also have been interested in the same aspects as Raute et al. They should be congratulated for their excellent results.

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