

Dilation Time in Endoscopic Papillary Balloon Dilation for Common Bile Duct Stones

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Background: To assess the short-term outcomes after endoscopic sphincterotomy (EST) plus endoscopic papillary balloon dilation (EPBD) versus EPBD alone and appropriate balloon dilation time in EPBD alone.

Materials and Methods: A total of 413 patients with common bile duct stones (CBDSSs) were included in the EST plus EPBD group and 84 were in the EPBD alone group. We retrospectively evaluated the safety and efficacy between EST plus EPBD and EPBD alone group. The patients in EPBD alone group were assigned to dilation time ≥ 5 minutes group ($n = 35$) and time < 5 minutes group ($n = 49$). Further, we preliminarily discussed the influence of balloon dilation time on the procedure-related complications.

Results: Compared with EST plus EPBD, the patients in EPBD alone group were younger [56.6 (range: 18 to 95) vs. 65.1 (24 to 92) y; $P = 0.006$], had smaller diameter of the largest stone [10.4 (range: 3 to 20) vs. 12.3 (5 to 30) mm; $P < 0.001$] and were lesser frequently performed with jaundice [22 (26.2%) vs. 189 (45.8%); $P = 0.001$]. The mean duration of postoperative hospital stay in EPBD alone group was significantly shorter than EST plus EPBD group [6.3 (range: 1 to 18) vs. 9.2 (1 to 44) d; $P < 0.001$]. The patients in EPBD alone group had higher risk of post endoscopic retrograde cholangiopancreatography pancreatitis than EST plus EPBD group [11 (13.1%) vs. 22 (5.3%); $P = 0.009$]. Patients in the dilation time < 5 minutes group had higher risk to suffer from postoperative pancreatitis than the EST plus EPBD group [9 (18.4%) vs. 22 (5.3%); $P = 0.002$], while patients in the dilation time ≥ 5 minutes group had less procedure-related hemorrhage than the EST plus EPBD group [0 vs. 36 (8.7%); $P = 0.047$].

Conclusion: Long balloon dilation time in EPBD alone is safe and effective in treating CBDSSs.

Key Words: common bile duct stones, complications, dilation time, endoscopic sphincterotomy, endoscopic papillary balloon dilation (*Surg Laparosc Endosc Percutan Tech* 2017;27:351–355)

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Nowadays, endoscopic retrograde cholangiopancreatography (ERCP) is widely supposed to precede surgical or percutaneous approaches as an alternative treatment for common bile duct stones (CBDSSs).¹ And endoscopic sphincterotomy (EST) is generally used as a standard endoscopic technique to clear stones for convenience. However, EST is associated with short-term complications, such as cholangitis, hemorrhage, pancreatitis and perforation. Alternatively, endoscopic papillary balloon dilation (EPBD) is considered to preserve the function of sphincter of Oddi and decrease the complications in EST, such as hemorrhage and perforation.^{2,3} On the contrary, EPBD is also thought to increase the risk of pancreatitis.⁴⁻⁶

Despite the frequent use of EPBD, limited studies have involved the influence of balloon dilation time on the complications. At present, no consensus has been reached on the suitable dilation time, which has depended on the operator's experience in most cases.

In the present research, we performed a retrospective study to compare the safety and efficacy in the groups of EST plus EPBD and EPBD alone, and further evaluated the effects of dilation time on the outcome of main complications in EPBD alone group.

MATERIALS AND METHODS

Study Design

The retrospective study was conducted with the approval of the local research ethics committee. Consecutive patients presenting for EST plus EPBD or EPBD alone with CBDSSs removal were enrolled in this study between September 2010 and October 2015. The following inclusion criteria were applied: (a) no younger than 18 years of age; (b) CBDSSs were extracted completely or incompletely regardless of mechanical lithotripsy (ML); (c) underwent ERCP procedure for the first time. Prior ERCP, precut, EPBD before EST, absent of CBDSSs and concomitant malignancy were excluded. The characteristics of these patients who underwent EST plus EPBD or EPBD alone were collected.

Endoscopic Retrograde Cholangiopancreatography Procedures

ERCP was performed using a standard duodenoscope (TJF-240 or TJF-260, Olympus Optical Co. Ltd., Tokyo, Japan) by expert endoscopists with patients in a prone position under sedation with intravenous propofol and/or remifentanyl or neither after signature of informed consent. Selective bile duct cannulation was taken, and a wire was advanced to the intrahepatic ducts. A cholangiogram was obtained, and common bile duct and stone diameters were defined with the external diameter of distal end of the

duodenoscope (12 mm) as a reference. Then the cannulation device was withdrawn over the wire and either EST plus EPBD or EPBD alone was chosen at discretion of the endoscopists to enlarge the opening of the duodenum papillary sphincter. In EPBD, the balloon was gradually inflated with diluted radiopaque contrast medium to the target diameter which was based on the distal common bile duct and stone diameters. In the EST plus EPBD group, EST was performed before EPBD from the orifice of the papilla proximally to the transverse fold (minor EST), and then EPBD was used with inflated balloon maintained in position for 60 seconds. Stones were removed by basket or retrieval balloon. ML was used if the stones were too large. Endoscopic nasobiliary drainage (ENBD), endoscopic retrograde biliary drainage or endoscopic retrograde pancreatic drainage was performed according to the decision of ERCP operators. An example of the procedure of EPBD was showed in Figure 1.

Outcome Parameters

The compared main outcome parameters included the therapeutic success, clinical characteristics, postoperative hospital stay, procedure-related drainage techniques and adverse events. Clinical characteristics contained general information of patients, symptoms, maximum diameter of the largest stone, periampullary diverticulum and accompanying disease status. According to dilation time, EPBD

alone group was divided to time ≥ 5 minutes (range from 5 to 6 min) and time < 5 minutes (range from 2 to 3 min) group. On the basis of Cotton et al's⁷ consensus, post-ERCP pancreatitis was defined as persistent abdominal pain for more than 24 hours with serum amylase at least 3 times normal. Cholangitis was defined as fever more than 38°C for longer than 24 hours ruling out other causes. Hemorrhage was considered with hemoglobin decrease of at least 2 g/dL, melena, hematemesis, and bloody fluid drainage in and after the process of ERCP. Perforation was made a definite diagnosis by imaging tests.

Statistical Analysis

Statistical analysis of the data were performed using the software package SPSS 19.0. The comparisons among different groups were evaluated by 1-way analysis of variance, χ^2 , and Fisher exact methods as appropriate. Results were considered statistically different when the analysis reached a *P*-value of < 0.05 .

RESULTS

Patients

The clinical characteristics of studied individuals are summarized in Table 1. A total of 497 patients were enrolled in this study, including 413 patients were treated with EST plus EPBD and 84 with EPBD alone. There were no differences

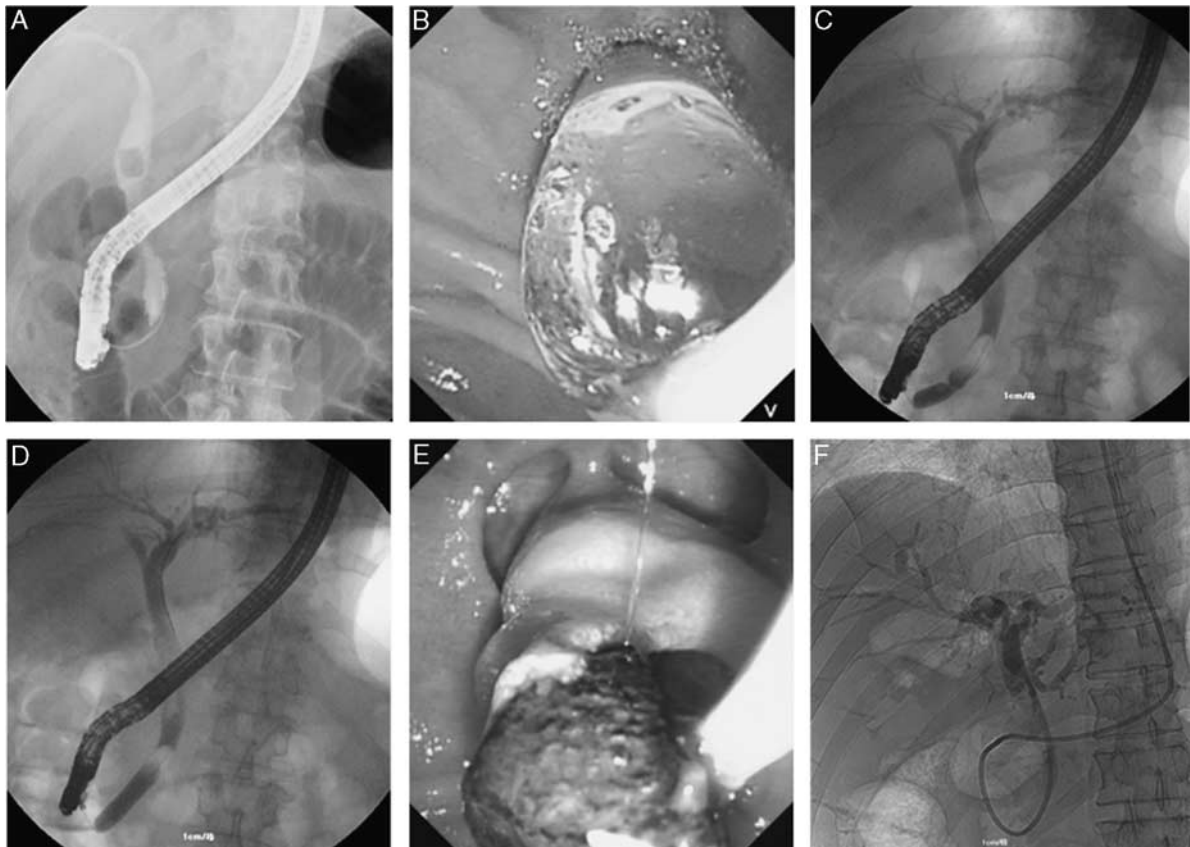


FIGURE 1. Endoscopic papillary balloon dilation (EPBD) procedure for the removal of a large common bile duct stone. A, Fluoroscopic view of a large common bile duct stone. B, Endoscopic view of EPBD. C, Fluoroscopic view of EPBD with a waist of the balloon. D, Fluoroscopic view of inflated balloon until the waist of the balloon disappeared. E, Endoscopic view of stone removed to the duodenum. F, Fluoroscopic view of complete stone removal.

TABLE 1. Clinical Characteristics of the Patients

	EST Plus EPBD (n = 413)	EPBD Alone (n = 84)	P
Male/female	189/224	38/46	0.930
Age (y)	65.1 (24-92)	56.6 (18-95)	0.006
Symptoms			
Abdominal pain	362 (87.7)	77 (91.7)	0.296
Fever	118 (28.6)	23 (27.4)	0.825
Jaundice	189 (45.8)	22 (26.2)	0.001
Maximum diameter of the largest stone (mm)	12.3 (5-30)	10.4 (3-20)	< 0.001
Periampullary diverticulum	171 (41.4)	29 (34.5)	0.241
Accompanying status			
Pancreatitis	38 (9.2)	6 (7.1)	0.545
Cholangitis	64 (15.5)	10 (11.9)	0.399
Gall stones	156 (37.8)	37 (44.0)	0.282
Previous cholecystectomy	137 (33.2)	28 (33.3)	0.977

Data are presented as mean (range) or n (%).

EPBD indicates endoscopic papillary balloon dilation; EST, endoscopic sphincterotomy.

between the 2 groups in sex, abdominal pain, fever, periampullary diverticulum, accompanying pancreatitis, cholangitis, gall stones, and previous cholecystectomy. Compared with EST plus EPBD, the patients of EPBD alone group were younger [56.6 (range: 18 to 95) vs. 65.1 (24 to 92)y; $P = 0.006$], had smaller diameter of the largest stone [10.4 (range: 3 to 20) vs. 12.3 (5 to 30)mm; $P < 0.001$] and were lesser frequently performed with jaundice [22 (26.2%) vs. 189 (45.8%); $P = 0.001$].

Therapy-related Parameters

Complete stone removal occurred in 392 patients by EST plus EPBD and in 80 patients by EPBD alone (Table 2). There was no significant difference in the therapeutic success between EST plus EPBD group and EPBD alone group irrespective of whether ML was used (94.9% vs. 95.2%, $P = 1.000$). The complete stone removal rate without using ML was also not statistically different between EST plus EPBD and EPBD alone group (88.6% vs. 92.9%, $P = 0.251$). In addition, the use of ML was not different between the 2 groups (EST plus EPBD group vs. EPBD alone group, 8.2% vs. 2.4%; $P = 0.059$). The drainage techniques used in ERCP procedure were similar between EST plus EPBD and EPBD alone group, including ENBD (85.0% vs. 88.1%, $P = 0.461$), endoscopic retrograde biliary drainage (1.5% vs. 1.2%, $P = 1.000$) and endoscopic retrograde pancreatic drainage (5.1% vs. 6.0%, $P = 0.955$). The mean postoperative hospital stay in EPBD alone group (6.3d, range: 1 to 18d) was significantly shorter than EST plus EPBD group (9.2d, range: 1 to 44d) ($P < 0.001$).

Adverse Events

As shown in Table 2, there were no differences in overall procedure-related complications between EST plus EPBD and EPBD alone group (19.4% vs. 20.2%, $P = 0.855$). A total of 22 (5.3%) patients in the EST plus EPBD group developed post-ERCP pancreatitis, and in the EPBD alone group the number was 11 (13.1%, $P = 0.009$). Nine (2.2%) patients in the EST plus EPBD group and 1 (1.2%) patient in the EPBD alone group suffered cholangitis ($P = 0.871$). In all, hemorrhage occurred in 36 (8.7%) patients of the EST plus EPBD group, which was

TABLE 2. Comparison of Short-term Outcomes Between Groups

	EST Plus EPBD (n = 413)	EPBD Alone (n = 84)	P
Complete stone removal irrespective of whether ML was used	392 (94.9)	80 (95.2)	1.000
Complete stone removal without ML	366 (88.6)	78 (92.9)	0.251
Related drainage techniques			
Endoscopic nasobiliary drainage	351 (85.0)	74 (88.1)	0.461
Endoscopic retrograde biliary drainage	6 (1.5)	1 (1.2)	1.000
Endoscopic retrograde pancreatic drainage	21 (5.1)	5 (6.0)	0.955
ML	34 (8.2)	2 (2.4)	0.059
Procedure-related adverse events			
Pancreatitis	22 (5.3)	11 (13.1)	0.009
Cholangitis	9 (2.2)	1 (1.2)	0.871
Hemorrhage	36 (8.7)	3 (3.7)	0.110
Perforation	1 (0.2)	1 (1.2)	0.310
Procedure-related death	0	0	-
Overall procedure-related complications	80 (19.4)	17 (20.2)	0.855
Postoperative hospital stay (d)	9.2 (1-44)	6.3 (1-18)	< 0.001

Data are presented as mean (range) or n (%).

EPBD indicates endoscopic papillary balloon dilation; EST, endoscopic sphincterotomy; ML, mechanical lithotripsy.

not statistically different with 3 (3.7%) patients in EPBD alone group ($P = 0.110$). One patient suffered a perforation in the EST plus EPBD group (0.2%) and EPBD alone group (1.2%), respectively ($P = 0.310$), and both patients recovered with conservative treatment. No ERCP-related death occurred in either group.

Influence of Dilation Time in EPBD Alone Group on Adverse Events

There were no differences between the time ≥ 5 minutes group and time < 5 minutes group in sex, age, abdominal pain, fever, jaundice, maximum diameter of the largest stone, periampullary diverticulum, accompanying pancreatitis, cholangitis, gall stones, and previous cholecystectomy (Supplement 1, Supplemental Digital Content 1, <http://links.lww.com/SLE/A160>). Nine (18.4%) patients in the dilation time < 5 minutes group suffered from postoperative pancreatitis, which was significantly more than the EST plus EPBD group (22 patients, 5.3%; $P = 0.002$), while the number of patients in the dilation time ≥ 5 minutes group (2, 5.7%) did not differ with the EST plus EPBD group (Table 3). Three (6.1%) patients in the dilation time < 5 minutes group were found to have procedure-related hemorrhage, while the number in the dilation time ≥ 5 minutes group was zero, which was statistically less than the EST plus EPBD group (36 patients, 8.7%; $P = 0.047$). The number of patients with cholangitis or perforation did not distinguish among the 3 groups.

DISCUSSION

EST and EPBD are both well-established methods of expanding the papillary opening before CBDSS clearance in therapeutic ERCP. Suitable balloon and pressure, slowly

TABLE 3. The Influence of EPBD Alone Time on the Procedure-related Adverse Events

	EST Plus EPBD (n = 413)	EPBD Alone (n = 84)		P
		Time ≥ 5 min (n = 35)	Time < 5 min (n = 49)	
Pancreatitis	22 (5.3)	2 (5.7)	9 (18.4)*	0.012
Cholangitis	9 (2.2)	0	1 (2.0)	0.678
Hemorrhage	36 (8.7)	0†	3 (6.1)	0.034
Perforation	1 (0.2)	1 (2.9)	0	0.231

Data are presented as n (%).

*P = 0.002 compared with EST plus EPBD group.

†P = 0.047 compared with EST plus EPBD group.

EPBD indicates endoscopic papillary balloon dilation; EST, endoscopic sphincterotomy.

balloon inflation and adequate dilation time are the guarantee of EPBD success, but a consensus still not been reached in the choice of EPBD alone or EST plus EPBD. In the current study, we found that endoscopists were inclined to choose EPBD alone in younger patients considering of preservation of sphincteric function. Several studies have shown that the sphincter of Oddi pressure could obtain a certain degree of recovery after EPBD alone, although not completed.^{2,8} A slice of reports demonstrated that patients undergoing EPBD alone were less successful in regard of stone clearance and more likely required ML,^{9,10} which led to more frequent using of EST plus EPBD in the patients with jaundice before operation in consideration of more effective biliary obstruction remission. The same reason might be responsible to choose EST plus EPBD in the face of larger stones, rather than EPBD alone. We often used ENBD after CBDSSs removal considering that it might reduce postoperative pancreatitis and cholangitis,¹¹ and could flush to promote the broken stones elimination. Routinely, we carried out nasobiliary radiography to ensure no residual stones at about 3 days after ERCP.

EST was usually performed in order to treat CBDSSs. EPBD had a lower risk for bleeding than EST, but quite a few studies showed that it increased the risk of pancreatitis. Disario et al¹² suggested that EPBD for stone extraction should be avoided because of increased risk of pancreatitis. However, balloon dilation itself might not be the cause of pancreatitis on the basis of reports involving antegrade EPBD.¹³ On the contrary, sufficient dilation of papillary sphincter could reduce the trauma to the papilla and pancreas by the basket or lithotripter during the process of stone removal.^{13,14} A series of studies revealed that short EPBD duration made more frequent pancreatitis than long duration. Liao et al^{4,15} advocated 5-minute EPBD improved efficacy of stone retrieval and reduced the risk of pancreatitis and demonstrated that duration of EPBD was inversely associated with pancreatitis risk. Our present study demonstrated that the dilation time has impacts on the post-ERCP pancreatitis risk, which was consistent with previous studies.^{4,15}

In addition to the pancreatitis, hemorrhage caused by ERCP procedure was brought to the attention of endoscopists. Theoretically, less hemorrhage is likely to occur in EPBD because it does not incise mucosa directly. Baron and Harewood⁹ showed that EPBD should be the preferred strategy over EST for endoscopic CBDSSs removal on the basis of lower bleeding rates. Because of the lower rates of

bleeding, EPBD was recommended to apply in patients with coagulopathy.¹⁶ There was no difference about hemorrhage complication between EST plus EPBD and EPBD alone group in our study, while long EPBD duration time decreased the risk of hemorrhage compared with EST plus EPBD. The underlying mechanism was not clear yet. The lengthening duration of balloon inflation reduced the risk of bleeding by probable oppressing function of balloon. Moreover, patients did not experience increased pain during EPBD because of effective intravenous anesthesia, which was no longer an obstacle to prolong dilation time. Duration time had no effect on perforation and cholangitis, which maybe due to the low incidence rate. Further studies were needed in a large scale.

In summary, our findings pointed out that EPBD with a long, 5 minutes balloon dilation time was safe and effective. The therapeutic success rates for CBDSSs using EPBD alone were comparable with EST plus EPBD. Furthermore, a long dilation time was associated with a declining incidence of procedure-related pancreatitis and hemorrhage. More prospective studies in large population are needed for clinical practice guidance.

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