

Ampulla dilation with different sized balloons to remove common bile duct stones

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quiring transfusion. There were no significant differences in early complication rates among the five groups. We observed significant correlations between increased balloon size and the short- and long-term rates of post-ERCP pneumobilia. Post-ERCP pancreatitis and bleeding correlated significantly with age, with post-ERCP pancreatitis occurring more frequently in patients aged < 60 years, and bleeding occurring more frequently in patients aged > 70 years. We observed a significant correlation between patient age and the diameter of the largest CBD stone, with stones > 12 mm occurring more frequently in patients > 60 years old.

CONCLUSION: Choosing a balloon size based on the largest stone diameter is safe and effective for removing CBD stones. Balloon size should not exceed 15 mm.

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Abstract

AIM: To assess the outcomes of ampulla dilation with different sized balloons to remove common bile duct (CBD) stones.

METHODS: Patients ($n = 208$) were divided into five groups based on the largest CBD stone size of < 5, 6-8, 8-12, 12-14, and > 14 mm. Patients underwent limited endoscopic sphincterotomy (EST) alone or limited EST followed by endoscopic papillary balloon dilation with 8, 10, 12 and 14 mm balloons, such that the size of each balloon did not exceed the size of the CBD. Short- and long-term outcomes, such as post-endoscopic retrograde cholangiopancreatography (ERCP) pancreatitis, perforation, bleeding, and pneumobilia were compared among the five groups.

RESULTS: The overall rate of successful stone removal in all groups was 100%, and all patients were cured. Eight (3.85%) patients had post-ERCP pancreatitis, none had perforations, and 6 (2.9%) had bleeding re-

Key words: Endoscopic papillary balloon dilation; Endoscopic sphincterotomy; Common bile duct stone; Endoscopic retrograde cholangiopancreatography; Pancreatitis

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INTRODUCTION

Endoscopic sphincterotomy (EST) and endoscopic papillary balloon dilation (EPBD) with balloons < 12 mm in diameter are the methods of choice for the removal of stones from the common bile duct (CBD)^[1-4]. Both methods, however, have distinct advantages and disadvantages. EST is associated with serious short-term complications, such as hemorrhage, perforation, and pancreatitis,

and long-term complications such as permanent loss of sphincter of Oddi (SO) function and recurrent bile duct infection^[5-7]. Although complications of bleeding and perforation seldom occur during EPBD^[8-10] and SO function can be preserved^[11,12], it is difficult to remove large CBD stones using EPBD because the biliary opening is not as enlarged as it is with EST, and EPBD is associated with a higher rate of post-endoscopic retrograde cholangiopancreatographic (ERCP) pancreatitis.

More recently, EPBD with large sized balloons (12-20 mm) has been used to remove large CBD stones following limited EST^[13-16]. It is unclear, however, whether the increase in balloon size is associated with increased rates of short-term complications, such as perforation and hemorrhage, or with preservation of SO function. Combining the advantages of EST and EPBD, by selecting the correct sized balloon and EST incision length to achieve a high rate of stone extraction, while minimizing complications of both procedures, would be of great benefit to the patients. We therefore prospectively investigated the short- and long-term outcomes of different sized balloons, chosen according to each patient's maximum CBD stone size, to dilate the papilla following limited EST.

MATERIALS AND METHODS

Patients

Patients with possible CBD stones, as diagnosed by biliary symptoms and abnormality of biliary enzymes, or whose presence was suspected through imaging modalities, such as ultrasound (US), computed tomography (CT) and/or magnetic resonance imaging (MRI) were screened. Patients were excluded if they had (1) severe acute pancreatitis (APACHE II ≥ 8 , or Balthazar CT score ≥ 4); (2) severe cholangitis with disturbance of consciousness and shock; (3) coagulopathies; (4) malignant diseases; (5) a history of previous EPBD or EST; (6) age > 85 years; (7) a CBD filled with stones; and (8) had undergone a Billroth II gastrectomy. Patients who met these criteria and lived in Shanghai, enabling follow-up, were fully informed about the methods and possible complications of the procedure, and were asked to provide written informed consent before ERCP. The study was approved by the Ethics Committee of Shanghai Gongli Hospital, and was supported by the Shanghai Municipal Health Bureau.

Patients were enrolled if selective deep cannulation to the CBD was successful, CBD stones were diagnosed by ERC, and an incision was made to the mid-portion of the papilla with a pull-type sphincterotomy. The diameter of the largest stone was determined by comparing it with the size of the endoscope tip. Patients were divided into five groups based on the largest CBD stone size, of (1) < 5 mm, (2) 6-8 mm, (3) 8-12 mm, (4) 12-14 mm, and (5) > 14 mm. These groups underwent limited EST alone without EPBD, and EPBD with balloons of 8, 10, 12 and 14 mm in diameter, respectively, such that the size of each balloon did not exceed the size of the CBD.

Methods

Pharyngeal anesthesia and premedication before the procedure, including the intravenous administration of diazepam, meperidine hydrochloride, and scopolamine, were performed in the same manner as for general endoscopy. ERCP was performed with a side-viewing endoscope (JF240; JF260V; Olympus, Tokyo, Japan).

Limited EST was performed according to the standard methods using a pull-type sphincterotomy. The incision was made up to the mid-portion of the papilla.

Endoscopic papillary balloon dilation

A balloon dilation catheter of 8, 10, 12 or 14 mm in diameter (Wilson-Cook Medical Inc., NC, United States), was inserted and inflated slowly with diluted contrast fluid until the waistline was obliterated under fluoroscopic monitoring and maintained for one min at 6 atm or 8 atm as required. After the balloon was deflated, the stones were extracted using a retrieval basket (Wilson-Cook Medical Inc., NC, United States) and/or a retrieval balloon (Extractor XL; Boston Scientific Corporation, MA, United States).

When the stone diameter was > 16 mm, as shown by diagnostic ERCP, a mechanical lithotripter (ML; BML-4Q; Olympus Corporation, Tokyo, Japan) was used to break the stones into fragments.

Follow-up

All patients were seen at the outpatient clinic six months to one year after discharge and every year thereafter. At each visit, blood and liver function tests, abdominal US and CT were performed. Other relevant examinations were performed when deemed necessary. If stone recurrence was suspected from symptoms, laboratory data, and/or images, ERCP was performed, and the recurrent stone was removed.

Outcome measures

Short-term outcomes included the rates of post-ERCP pancreatitis, bleeding requiring transfusion, perforation, pneumobilia and mortality. Long-term (2-5 years) outcomes included the rates of reflux cholangitis, pneumobilia, and recurrence of CBD stones.

Statistical analysis

Statistical analyses were performed using statistical software (SPSS 12.0 for Windows; SPSS Inc., Chicago, IL, United States). Quantitative data were presented as the mean \pm SD. The χ^2 test or Fisher's exact test was used to compare sex distribution, and rates of mechanical lithotripter (ML) use, gallbladder *in situ*, concomitant gallbladder stones, and early and later complications in the 5 groups. ANOVA was used to compare age, number of stones, diameter of largest stone, and relationships between age and post-ERCP pancreatitis and bleeding in the 5 groups. A *P* value < 0.05 was considered statistically significant.

Table 1 Demographic data and baseline characteristics of the 5 patient groups

	Balloon diameter					<i>P</i> value
	EST alone (<i>n</i> = 42)	8 mm (<i>n</i> = 35)	10 mm (<i>n</i> = 87)	12 mm (<i>n</i> = 29)	14 mm (<i>n</i> = 15)	
Sex (F/M)	20/22	19/16	50/37	15/14	9/6	0.832
Age (yr)	55.6 ± 13.1	59.5 ± 14.2	66.8 ± 15.5	72.8 ± 11.8	74 ± 5.3	0.003
No. of stones	2.0 ± 1.0	2.2 ± 1.0	2.1 ± 1.4	2.1 ± 1.0	2.3 ± 1.0	0.994
Diameter of largest stone (mm)	5.5 ± 1.5	7.0 ± 2.0	9.3 ± 2.1	10.3 ± 2.7	14.7 ± 1.2	0.000
Use of mechanical lithotripter	0	0	0	0	4	0.000
Gallbladder <i>in situ</i>	33	29	74	21	10	0.358
Concomitant gallbladder stones	26	22	61	18	7	0.795
Sessions required for complete stone removal						
Single session	42	35	87	28	13	
Two sessions	0	0	0	1	2	

F: Female; M: Male; EST: Endoscopic sphincterotomy.

RESULTS

Patient characteristics and early complications

We enrolled 208 consecutive patients (95 males and 113 females), all of whom were diagnosed with CBD stones by ERC and underwent successful selective deep cannulation to the CBD at our institution between January 1, 2006, and January 1, 2008. Mean patient age was 62.4 ± 15.0 years. Stones were successfully removed from all the patients in all 5 groups. The demographic data and baseline characteristics of the 5 groups are shown in Table 1.

We observed a significant correlation between patient age and the diameter of the largest stone, with stones > 12 mm occurring more frequently in patients > 60 years old. The ML was used more often in patients with larger CBD stones, especially for stones > 16 mm in diameter. Although the overall success rate of stone removal was 100% in all groups, two patients in the 14 mm balloon group and one in the 12 mm group each required 2 sessions for stone removal due to patient intolerance of a long operation time to remove large stones.

Early complications

All patients were cured, none died, and none had a perforation. We found that 8 (3.85%) patients had post-ERCP pancreatitis, including 1 in the 10 mm balloon dilation group who had severe pancreatitis. All patients were cured by conservative treatments. Six (2.9%) patients experienced upper gastrointestinal bleeding requiring transfusions, including 2 patients with bleeding in the stomach and 4 with bleeding in the duodenal papilla. Two patients were cured by angiographic embolization and 1 by laparotomy to ligate the bleeding vessel after 2 attempts of endoscopic clamping and 1 of angiographic embolization all failed. The other 3 patients were cured conservatively. There were no significant differences in early complication rates among the five groups.

Pneumobilia occurred in 55 (26.4%) patients at a mean of 4.9 ± 0.7 d (range, 3-7 d) after ERCP. We observed a significant correlation between increased balloon size and the incidence of pneumobilia, suggesting that dilation with a large balloon may cause more damage to SO function. Details of early complications are described

in Table 2.

Interestingly, post-ERCP pancreatitis and bleeding correlated significantly with age, with post-ERCP pancreatitis occurring more frequently in patients aged < 60 years, and bleeding occurring more frequently in patients aged > 70 years. The 8 patients with post-ERCP pancreatitis were significantly younger than the 200 who did not develop post-ERCP pancreatitis (51.1 ± 8.3 years *vs* 63.5 ± 15.1 years, $P = 0.026$). Conversely, the 6 patients with bleeding were significantly older than the 202 who did not develop bleeding (75.7 ± 7.1 years *vs* 61.4 ± 15.0 years, $P = 0.024$).

Later complications

Of the 208 patients, 192 (92.3%) were followed up for at least 2 years, with a mean follow-up time of 3.2 ± 1.1 years (range, 2-5 years). There were no significant differences in the rates of later complications, including reflux cholangitis and recurrence of CBD stones, among the 5 patient groups.

The incidence of pneumobilia one year after ERCP was significantly lower than shortly after ERCP, suggesting that SO function had recovered, at least partially, in these patients. We observed a significant correlation between the size of the dilation balloon and the 1-year incidence of pneumobilia, suggesting that larger balloons may cause more damage to SO function. The details of later complications in each group are shown in Table 2.

DISCUSSION

As no standard endoscopic procedure has been developed to date to maximize the effects and minimize the complications of EST and EPBD^[17,18], we prospectively assessed a method combining EPBD with limited EST. CBD stone sizes vary, from 3-5 mm in diameter to 15-30 mm in diameter, or even larger, suggesting that an endoscopic treatment method should be based on stone size. We therefore utilized limited EST alone for CBD stones < 5 mm in diameter, and limited EST followed by EPBD with balloons of 8, 10, 12 and 14 mm for CBD stones 6-8, 8-12, 12-14 and > 14 mm, respectively. We found that tailoring balloon size to stone size was safe and effective,

Table 2 Early and later complications in the 5 patient groups

	Balloon size					<i>P</i> value
	EST alone (<i>n</i> = 42)	8 mm (<i>n</i> = 35)	10 mm (<i>n</i> = 87)	12 mm (<i>n</i> = 29)	14 mm (<i>n</i> = 15)	
Early complications						
Post-ERCP pancreatitis	1	2	3	1	1	0.918
Perforation	0	0	0	0	0	
Bleeding	1	1	3	1	0	0.961
Incidence of pneumobilia	7	5	25	11	7	0.039
Later complications						
Long term outcome						
Incidence of pneumobilia	2	1	10	5	4	0.029
Reflux cholangitis	0	0	2	2	1	0.235
Recurrence of CBD stones	0	0	2	1	0	0.624

ERCP: Endoscopic retrograde cholangiopancreatography; EST: Endoscopic sphincterotomy; CBD: Common bile duct.

with low rates of short- and long-term complications.

Limited EST was sufficient to remove CBD stones < 5 mm in diameter, as the biliary opening was large enough to remove these stones. EPBD was not required as balloons larger than CBD stones can cause more damage to SO function. We found that limited EST did not cause any perforations, an often fatal complication and even more serious than pancreatitis and bleeding, and preserved SO function.

We also found that limited EST followed by EPBD with balloons < 12 mm in size could partially preserve SO function. Although limited EST plus EPBD with balloons 12–14 mm in size did not cause any perforations, it was associated with higher rates of pneumobilia, both shortly after ERCP and ≥ 2 years later, compared with limited EST alone or followed by EPBD with smaller balloons, suggesting that large balloons result in greater damage to SO function.

Limited EST followed by EPBD has several benefits, including a lower incidence of post-ERCP pancreatitis. After EST, the openings of the pancreatic duct and common bile duct separate, decreasing the pressure on the pancreatic duct caused by EPBD and papillary edema^[19]. Using limited EST in all our patients with CBD stones, we found that the overall incidence of post-ERCP pancreatitis was 3.85%, lower than previously reported^[5-7,10]. Limited EST combined with EPBD can also make cannulation easier and reduce the procedure and fluoroscopy times^[20] by shortening the cannulation length, and is safer than full EST or EPBD alone, because full EST may lead to perforation, while EPBD alone may lead to post-ERCP pancreatitis. Furthermore, limited EST is easier to perform than full EST. We have successfully utilized this method to remove large CBD stones since 1999^[21], and have found that it is a good choice for different sized CBD stones.

Large balloon dilation of the papilla may make the removal of CBD stones easier, reducing the need for an ML, and shortening cannulation and stone removal times, thus decreasing the incidence of post-ERCP pancreatitis. However, we did not use a balloon > 15 mm. A recent study in animals showed that EPBD with balloons < 15

mm was safe, with no perforations, whereas balloons > 15 mm was associated with a significantly higher rate of perforation^[22]. In contrast, the use of 8 mm balloons in animals showed that EPBD was not associated with fibrosis or altered papillary architecture^[23] and many clinical reports have shown that EPBD with large balloons > 15 mm was effective and safe^[13-16]. However, the risk of perforation is higher with large balloons, prolonging hospitalization and increasing costs. We also found that increased dilation size was significantly associated with an increased incidence of pneumobilia, indicating that dilation with large balloons may cause more damage to SO function. Although we found no significant differences in later complications, such as reflux cholangitis and recurrence of CBD stones among the 5 patient groups, follow-up time may not have been sufficiently long. SO function is important in preventing biliary diseases, such as acute cholecystitis, cholangitis and recurrence of CBD stones^[24], suggesting that preserving SO physiological function may be advantageous, especially in younger patients. Our findings also indicate that 14 mm balloons were large enough to remove CBD stones > 15 mm, assisted by an ML. Taken together, our findings indicate that limited EST, followed by EPBD with balloons < 15 mm is safe.

We found that the rate of post-ERCP pancreatitis and bleeding correlated with patient age, with patients < 60 years more frequently having post-ERCP pancreatitis and patients > 70 years more prone to bleeding. The progressive decline in pancreatic exocrine function with age may protect older patients from pancreatic injury^[25,26]. In contrast, the Oddi muscle may be stronger in younger than in older patients, resulting in more difficult dilation in the former and a higher rate of pancreatitis. Although bleeding has seldom been reported after EPBD, we found that 6 (2.9%) of our patients had upper gastrointestinal bleeding requiring transfusions. All 6 were > 65 years old, with a mean age of 76 years. Older patients may be more prone to bleeding due to the relative inelasticity of their blood vessels. We also observed a correlation between CBD stone size and patient age, with stones > 12 mm occurring more frequently in patients > 60 years old.

The main limitation of this study was that we evaluated SO function by pneumobilia incidence, and not by endoscopic manometry. Manometry requires cannulation to the CBD, making it painful for patients and unacceptable during follow-up. Other limitations include the performance of this study at a single center, the relatively small number of patients, and the relatively short follow-up period.

In conclusion, limited EST, alone or followed by EPBD with balloons 8-14 mm, is safe and effective for the removal of different sized CBD stones. Choosing balloon size based on CBD stone size can maximize outcomes and minimize the complications of both EST and EPBD. Balloons > 15 mm in size are not necessary.

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COMMENTS

Background

Common bile duct (CBD) stones are very common, and patients are traditionally treated by open CBD exploration. With the advent of invasive endoscopic techniques, more patients are being treated endoscopically. However, endoscopists are often faced with difficult treatment decisions: endoscopic sphincterotomy (EST) or endoscopic papillary balloon dilation (EPBD)? Both methods have distinct advantages and disadvantages. The authors of this study prospectively investigated the short- and long-term outcomes of different sized balloons to dilate the papilla following limited EST.

Research frontiers

Both EST and EPBD are used for patients with CBD stones. Limited EST combined with EPBD has become popular for the removal of CBD stones in recent years, as it is thought to maximize outcomes and minimize the complications of both EST and EPBD.

Innovations and breakthroughs

This study investigated the short- and long-term outcomes of different sized balloons, chosen according to each patient's maximum CBD stone size, to dilate the papilla following limited EST. The authors found that choosing a balloon size no more than 15 mm based on the diameter of each patient's largest CBD stone is a good choice for removing CBD stones.

Applications

EPBD using a balloon size no more than 15 mm based on the diameter of patient's largest CBD stone following limited EST was proven to be a safe and effective treatment for CBD stones, and should be recommended for patients with CBD stones.

Terminology

ERCP: endoscopic retrograde cholangiopancreatography, a technique that combines the use of endoscopy and fluoroscopy to diagnose and treat certain problems of the biliary or pancreatic ductal systems; EST: endoscopic sphincterotomy, a minimally invasive surgery that was developed on the basis of ERCP to treat biliary or pancreatic ductal disease, the incision is made up to the full-portion of the papilla; Limited EST: like EST, the incision is made up to the mid-portion of the papilla; EPBD: endoscopic papillary balloon dilation, the papilla is dilated with a balloon to facilitate the removal of CBD stones.

Peer review

This is a good study in which authors evaluate the short- and long-term outcomes of different sized balloons to dilate the papilla following limited EST. The results are interesting and suggest that choosing balloon size no more than 15 mm based on the diameter of each patient's largest CBD stone is a good choice for removing CBD stones.

REFERENCES

- Ikeda S, Tanaka M, Matsumoto S, Yoshimoto H, Itoh H. Endoscopic sphincterotomy: long-term results in 408 patients with complete follow-up. *Endoscopy* 1988; **20**: 13-17 [PMID: 3342766 DOI: 10.1055/s-2007-1018117]
- Rabenstein T, Schneider HT, Hahn EG, Ell C. 25 years of endoscopic sphincterotomy in Erlangen: assessment of the experience in 3498 patients. *Endoscopy* 1998; **30**: A194-A201 [PMID: 9932780]
- Mac Mathuna P, White P, Clarke E, Lennon J, Crowe J. Endoscopic sphincteroplasty: a novel and safe alternative to papillotomy in the management of bile duct stones. *Gut* 1994; **35**: 127-129 [PMID: 8307433]
- Komatsu Y, Kawabe T, Toda N, Ohashi M, Isayama M, Tateishi K, Sato S, Koike Y, Yamagata M, Tada M, Shiratori Y, Yamada H, Ihori M, Kawase T, Omata M. Endoscopic papillary balloon dilation for the management of common bile duct stones: experience of 226 cases. *Endoscopy* 1998; **30**: 12-17 [PMID: 9548037 DOI: 10.1055/s-2007-993721]
- Cotton PB. Endoscopic management of bile duct stones; (apples and oranges). *Gut* 1984; **25**: 587-597 [PMID: 6376290]
- Freeman ML, Nelson DB, Sherman S, Haber GB, Herman ME, Dorsher PJ, Moore JP, Fennerty MB, Ryan ME, Shaw MJ, Lande JD, Pheley AM. Complications of endoscopic biliary sphincterotomy. *N Engl J Med* 1996; **335**: 909-918 [PMID: 8782497 DOI: 10.1056/NEJM199609263351301]
- Lauri A, Horton RC, Davidson BR, Burroughs AK, Dooley JS. Endoscopic extraction of bile duct stones: management related to stone size. *Gut* 1993; **34**: 1718-1721 [PMID: 8282260]
- Bergman JJ, Rauws EA, Fockens P, van Berkel AM, Bossuyt PM, Tijssen JG, Tytgat GN, Huibregtse K. Randomised trial of endoscopic balloon dilation versus endoscopic sphincterotomy for removal of bileduct stones. *Lancet* 1997; **349**: 1124-1129 [PMID: 9113010]
- Watanabe H, Yoneda M, Tominaga K, Monma T, Kanke K, Shimada T, Terano A, Hiraishi H. Comparison between endoscopic papillary balloon dilatation and endoscopic sphincterotomy for the treatment of common bile duct stones. *J Gastroenterol* 2007; **42**: 56-62 [PMID: 17322994 DOI: 10.1007/s00535-006-1969-9]
- Mathuna PM, White P, Clarke E, Merriman R, Lennon JR, Crowe J. Endoscopic balloon sphincteroplasty (papillary dilation) for bile duct stones: efficacy, safety, and follow-up in 100 patients. *Gastrointest Endosc* 1995; **42**: 468-474 [PMID: 8566640]
- Sato H, Kodama T, Takaaki J, Tatsumi Y, Maeda T, Fujita S, Fukui Y, Ogasawara H, Mitsufuji S. Endoscopic papillary balloon dilatation may preserve sphincter of Oddi function after common bile duct stone management: evaluation from the viewpoint of endoscopic manometry. *Gut* 1997; **41**: 541-544 [PMID: 9391256]
- Yasuda I, Tomita E, Enya M, Kato T, Moriwaki H. Can endoscopic papillary balloon dilation really preserve sphincter of Oddi function? *Gut* 2001; **49**: 686-691 [PMID: 11600473]
- Ersoz G, Tekesin O, Ozutemiz AO, Gunsar F. Biliary sphincterotomy plus dilation with a large balloon for bile duct stones that are difficult to extract. *Gastrointest Endosc* 2003; **57**: 156-159 [PMID: 12556775 DOI: 10.1067/mge.2003.52]
- Kim HG, Cheon YK, Cho YD, Moon JH, Park do H, Lee TH, Choi HJ, Park SH, Lee JS, Lee MS. Small sphincterotomy combined with endoscopic papillary large balloon dilation versus sphincterotomy. *World J Gastroenterol* 2009; **15**: 4298-4304 [PMID: 19750573]
- Rebello A, Ribeiro PM, Correia AP, Cotter J. Endoscopic papillary large balloon dilation after limited sphincterotomy for difficult biliary stones. *World J Gastrointest Endosc* 2012; **4**:

- 16 **Youn YH**, Lim HC, Jahng JH, Jang SI, You JH, Park JS, Lee SJ, Lee DK. The increase in balloon size to over 15 mm does not affect the development of pancreatitis after endoscopic papillary large balloon dilatation for bile duct stone removal. *Dig Dis Sci* 2011; **56**: 1572-1577 [PMID: 20945093 DOI: 10.1007/s10620-010-1438-4]
- 17 **Aiura K**, Kitagawa Y. Current status of endoscopic papillary balloon dilation for the treatment of bile duct stones. *J Hepatobiliary Pancreat Sci* 2011; **18**: 339-345 [PMID: 21161289 DOI: 10.1007/s00534-010-0362-5]
- 18 **Chung JW**, Chung JB. Endoscopic papillary balloon dilation for removal of choledocholithiasis: indications, advantages, complications, and long-term follow-up results. *Gut Liver* 2011; **5**: 1-14 [PMID: 21461066 DOI: 10.5009/gnl.2011.5.1.1]
- 19 **Stefanidis G**, Christodoulou C, Manolakopoulos S, Chuttani R. Endoscopic extraction of large common bile duct stones: A review article. *World J Gastrointest Endosc* 2012; **4**: 167-179 [PMID: 22624068 DOI: 10.4253/wjge.v4.i5.167]
- 20 **Itoi T**, Itokawa F, Sofuni A, Kurihara T, Tsuchiya T, Ishii K, Tsuji S, Ikeuchi N, Moriyasu F. Endoscopic sphincterotomy combined with large balloon dilation can reduce the procedure time and fluoroscopy time for removal of large bile duct stones. *Am J Gastroenterol* 2009; **104**: 560-565 [PMID: 19174779 DOI: 10.1038/ajg.2008.67]
- 21 **Li NP**, Yang WX, Liu JQ, Yang ZQ, Geng ZJ, Zhou MQ, Lu DR. Endoscopic papillary balloon dilation in the treatment of common bile duct stones. *Zhongguo Weichuang Waike Zazhi* 2003; **3**: 28-29
- 22 **Hisatomi K**, Ohno A, Tabei K, Kubota K, Matsushashi N. Effects of large-balloon dilation on the major duodenal papilla and the lower bile duct: histological evaluation by using an ex vivo adult porcine model. *Gastrointest Endosc* 2010; **72**: 366-372 [PMID: 20674625]
- 23 **Mac Mathuna P**, Siegenberg D, Gibbons D, Gorin D, O'Brien M, Afdhal NA, Chuttani R. The acute and long-term effect of balloon sphincteroplasty on papillary structure in pigs. *Gastrointest Endosc* 1996; **44**: 650-655 [PMID: 8979052]
- 24 **Yasuda I**, Fujita N, Maguchi H, Hasebe O, Igarashi Y, Murakami A, Mukai H, Fujii T, Yamao K, Maeshiro K, Tada T, Tsujino T, Komatsu Y. Long-term outcomes after endoscopic sphincterotomy versus endoscopic papillary balloon dilation for bile duct stones. *Gastrointest Endosc* 2010; **72**: 1185-1191 [PMID: 20869711 DOI: 10.1016/j.gie.2010.07.006.]
- 25 **Wang P**, Li ZS, Liu F, Ren X, Lu NH, Fan ZN, Huang Q, Zhang X, He LP, Sun WS, Zhao Q, Shi RH, Tian ZB, Li YQ, Li W, Zhi FC. Risk factors for ERCP-related complications: a prospective multicenter study. *Am J Gastroenterol* 2009; **104**: 31-40 [PMID: 19098846 DOI: 10.1038/ajg.2008.5.]
- 26 **Weinberg BM**, Shindy W, Lo S. Endoscopic balloon sphincter dilation (sphincteroplasty) versus sphincterotomy for common bile duct stones. *Cochrane Database Syst Rev* 2006; (4): CD004890 [PMID: 17054222 DOI: 10.1002/14651858.CD004890.pub2]

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