경피경간담도경 검사를 받는 환자에서 합병증의 위험인자

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Clinical Risk Factors for Complications in Patients Undergoing Percutaneous Transhepatic Cholangioscopy

Sung Yong Han^{1*}, Tae Wook Kim^{1*}, Dong Uk Kim¹, Young Joo Park¹, Moon Won Lee¹, Suk Kim², Dong Hoon Baek¹, Gwang Ha Kim¹, Geun Am Song¹¹Department of Internal Medicine, Biomedical Research Institute, Pusan National University Hospital, Busan; ²Department of Radiology, Biomedical Research Institute, Pusan National University Hospital, Busan, Korea**Background/Aim:** Percutaneous transhepatic cholangioscopy (PTCS) has been widely used for the diagnosis and treatment. PTCS-related complications (hemobilia, cholangitis, biliary tract perforations) are not infrequent. However, data on the risk factors for PTCS-related complications are limited. Therefore, we aimed to identify the risk factors for PTCS-related complications.**Methods:** Two hundred thirty-three patients who underwent PTCS at a single tertiary center between January 2006 and October 2014 were enrolled. After retrospectively analyzing the patients' medical records, 212 patients were enrolled and classified into two groups: 1) a complication group and 2) a non-complication group.**Results:** The study population comprised 112 men and 100 women, with a median age of 64.5 years. Of the 212 patients, 32 (15.1%) developed complications: 14 (6.7%) developed cholangitis, six (2.8%) developed bile duct injury, and two (0.9%) developed hemobilia. In the univariate analyses, older age, a small number of tract dilatation sessions, and computed tomography (CT) findings of liver cirrhosis and a non-dilated intrahepatic duct were risk factors for PTCS-related complications. In the multivariate analysis, older age, a small number of tract dilatation sessions, and the CT finding of a non-dilated intrahepatic duct were independent factors for predicting PTCS-related complications. Serial tract dilatations (≥ 2 sessions) were performed in 95 patients (44.8%), but this did not affect the complication rate. In this subgroup of patients, a short interval between sessions (≤ 3 days) was associated with PTCS-related complications.**Conclusions:** Elderly patients and those with non-dilated intrahepatic ducts on CT need to be managed carefully. Stepwise tract dilatations and a long interval between sessions (>3 days) can help decrease PTCS-related complications.**Received** Aug. 22, 2019**Revised** Dec. 2, 2019**Accepted** Dec. 3, 2019**Corresponding author : Dong Uk Kim**

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INTRODUCTION

Percutaneous transhepatic cholangioscopy (PTCS) has been widely used for the diagnosis and treatment of intrahepatic and extrahepatic biliary disease.¹⁻⁵ It is particularly useful for intrahepatic stones and cholangiocarcinomas, which have a high incidence in Northeast Asia, including Korea and Japan.³ PTCS is not straight forward to perform because it involves several stages, including a relatively long preparatory stage, and can only be carried out by experienced endoscopists. However, PTCS is difficult to replace with other procedures because it is performed in non-operable cases and in cases that cannot be treated with percutaneous transhepatic biliary drainage (PTBD) or endoscopic retrograde cholangiopancreatography.

PTCS-related complications such as hemobilia, cholangitis, and biliary tract perforations are not infrequent. However, previous studies do not provide a representative picture of PTCS-related morbidity and mortality.⁶⁻⁹ There are several reasons for this lack of representativeness: the available data have been limited; studies have focused only on patients with a particular condition, such as patients who underwent lithotripsy for intrahepatic stones; and the numbers of investigated patients have been limited over long study periods. One previous study showed that rapid tract dilatation was associated with an increased rate of PTCS-related complications and mortality.¹⁰ Currently, however, the preparations for PTCS are performed empirically because there is no fixed protocol

regarding elements such as the tract dilatation interval, number of dilatation sessions, and tract maturation time. Furthermore, the prediction and prevention of complications has not been possible because of the lack of studies on PTCS-related complications and their risk factors.

We aimed to investigate the incidence, characteristics, and risk factors of complications in patients who had undergone PTCS. Our study focused on predicting the risk of complications based on patient characteristics, CT findings, and the type of PTCS. Further, we examined the potential for preventing PTCS-related complications by adjusting the preparatory stage protocol.

METHODS

1. Patients

Between January 2006 and October 2014, a total of 233 patients underwent PTCS at Pusan National University Hospital. Of these patients, those who underwent PTCS (including PTBD, tract dilatation, and tract maturation) at Pusan National University Hospital were considered for inclusion in this study. Twenty-one patients were excluded: five because they were transferred to Pusan National University Hospital after PTBD, 10 because of incomplete medical records, and six because of insufficient follow-up duration (<4 weeks after PTCS; Fig. 1). Patients who had undergone postoperative

Fig. 1. Flow chart illustrating the progress of patients through the study.

cholangioscopy using a T-tube tract were also excluded from this study. Out of 233 patients, 212 were enrolled in this study. Clinical information was collected through a retrospective review of medical records. The study protocol was reviewed and approved by the Institutional Review Board of the Pusan National University Hospital (H-1910-004-083).

2. Preparation for cholangioscopy

Thirty minutes before the procedure, empirical antibiotics (2nd generation cephalosporin) were administered to patients for the prevention of cholangitis and other infections. If necessary, fresh frozen plasma, platelet concentrate, and/or packed red blood cells were transfused. PTBD was performed using an 8.5-Fr catheter (Cook Medical Inc., Bloomington, IN, USA). If PTBD-related complications such as infection and bleeding did not occur, the percutaneous tract was dilated to allow passage of the cholangioscope. Percutaneous tract dilatation was performed in a single session or in serial sessions (2–4 sessions) using 10-Fr, 12-Fr, 14-Fr, 16-Fr, and 18-Fr Foley catheters. The number of sessions of dilatation was determined by the radiologist with reference to the dilatation of the bile duct and the pain and complications of the previous procedure. The tract dilatation was performed when the patient's pain and complications improved. A 16-Fr or 18-Fr Foley catheter was placed for tract maturation. Tract maturation was performed during hospitalization or in nursing homes after discharge. PTBD and track dilation was performed by a single expert radiologist with experience of at least 200 procedures.

Cholangioscopy was performed using a 5.2-mm-diameter cholangioscope (CHF P20Q; Olympus Optical Co. Ltd., Tokyo, Japan), with routine injection of meperidine (25 mg). All PTCS sessions were performed by two endoscopists who had experience with at least 40 PTCS procedures over the course of 3–6 years. All of these procedures were performed by a single endoscopist with experience of at least 150 PTCS sessions.

3. Definition of complications

The PTCS procedure is completed in four stages: 1) PTBD, 2) tract dilatation, 3) tract maturation, and 4) PTCS. A complication was considered to be PTCS-related if it occurred between the day on which PTBD was performed and 3 days after the last PTCS session, and it had a large impact on the clinical course, prolonging hospitalization and/or requiring invasive intervention. These included complications occurring within several days after PTBD, tract dilatation, tract maturation, and PTCS. Bile duct injury was defined as occurring of bile leakage or biloma. Cholangitis is defined as the presence of fever or bacteremia that is not explained by other causes after the procedure. When more than one complication occurred as a single event, the most severe complication was included in the analysis. PTBD, tract dilatation, and maturation were defined as the preparatory stage and the several PTCS sessions were defined as the PTCS stage. Serial tract dilatations were defined as dilating cutaneobiliary fistulas two or more times using a thicker Foley catheter in a stepwise manner. The tract maturation time refers to the period between the last tract dilatation session and the first PTCS session.

4. Estimation of risk factors

To investigate the risk factors for PTCS-related complications, we analyzed the patients' characteristics (age, sex, and initial diagnosis), CT findings (liver cirrhosis, focal atrophy of liver parenchymal, and intrahepatic duct dilatation), the type of PTCS (the access hepatic duct, diagnostic or therapeutic use, and the presence of electrohydraulic lithotripsy [EHL] or balloon dilatation of ampulla of vater or intrahepatic duct), and the preparation for and process of the procedure (serial or single tract dilatation, number of tract dilatation sessions, tract maturation time, and number of PTCS sessions). The analysis compared patients with and without complications. Diagnosis based on CT was confirmed by two or more radiologists.

5. Statistical analysis

Patients with complications and those without complications were compared using the *t*-test or Chi-squared test and logistic regression analysis. Among the patients who underwent serial tract dilatations, differences between those who experienced complications and those who did not were evaluated using the Chi-squared test or Fisher's exact test. Patients were analyzed according to the number of tract dilatation sessions (2 vs. ≥ 3 session) and the tract dilatation interval (≤ 3 days vs. > 3 days). Statistical calculations were performed using SPSS version 21.0 for Windows (SPSS, Chicago, IL, USA). Results were considered statistically significant when the *p*-value was < 0.05 .

RESULTS

1. Baseline clinical data

A total of 212 patients were included during from January 2006 to October 2014 in the study (112 male, 100 female; median age, 64.5 years; range 16-88 years). Of the 212 patients, 35 underwent PTCS for diagnostic purposes and 177 underwent PTCS for therapeutic purposes. Sixty-four patients

had underlying diseases or conditions that could increase the risk of developing PTCS-related complications, such as malignancies ($n=15$), liver cirrhosis ($n=18$), Billroth II and bilioenteric anastomosis ($n=29$), and chronic renal failure ($n=3$). Patients were most commonly initially diagnosed with intrahepatic duct stones; other presentations included extrahepatic duct stones, benign strictures of the bile duct, bile duct carcinomas, and bilioenteric anastomosis strictures (Table 1). Before PTCS, extrahepatic stone removal by endoscopic retrograde cholangiopancreatography failed in 39 patients. Ninety-five patients underwent serial tract dilatations. The mean interval between sessions was 5.4 days and the mean number of sessions was 2.3. The mean tract maturation period was 14.3 days.

2. PTCS-related complications

Of the 212 patients who underwent all PTCS stages, 32 (15.1%) developed complications: during the preparatory stage in 20 patients (9.4%) and during the PTCS stage (total of 598 sessions) in 12 patients (5.7%, 2.0% per PTCS session). The incidence of complications according to the number of sessions was not statistically different, but tended to be high at first (1st

Table 1. Baseline characteristics and initial diagnosis of the enrolled patients

Number of patients	Value (n=212)
Sex (male)	112 (52.8)
Median age (years)	64.5 (16-88)
Initial diagnosis	
Intrahepatic duct stone	111 (52.4)
Extrahepatic duct stone	57 (26.9)
Benign stricture of the bile duct	18 (8.5)
Bilioenteric anastomosis stricture	4 (1.9)
Bile duct carcinoma	15 (7.1)
Hepatocellular carcinoma with bile duct invasion	1 (0.5)
Ampulla of Vater cancer	2 (0.9)
Bile duct dilatation without suspected cause	1 (0.5)
Others	3 (1.4)

Values are presented as median (interquartile range) or number (%).

Table 2. Complications during the preparatory and PTCS stages

	Preparatory stage (n=212)	PTCS stage (598 sessions)
None	192 (90.6)	586 (98.0)
Cholangitis	10 (4.7)	4 (0.7)
Bile duct injury	2 (0.9)	4 (0.7)
Hemobilia	0	2 (0.3)
Right pleural effusion	1 (0.5)	2 (0.3)
Stress-induced cardiomyopathy	1 (0.5)	0
Cardiogenic shock	1 (0.5)	0
Hepatic artery rupture	1 (0.5)	0
Peritonitis	1 (0.5)	0
Pancreatitis	2 (0.9)	0
Complication rate (%)	20/212 (9.4)	12/598 (2.0)

Values are presented as number (%) unless otherwise indicated. PTCS, percutaneous transhepatic cholangioscopy.

vs. 2nd vs. 3rd session; 6 [2.8%]/4 [1.9%]/2 [1.7%]). The most common complication was cholangitis (14 patients, 6.7%), followed by bile duct injury (six patients, 2.8%) (Table 2). None of the patients died.

3. Risk factors for complications

Table 3 summarizes the risk factors for complications. In the univariate analyses, the incidence of complications increased in elderly patients ($p<0.001$), those with liver cirrhosis and intrahepatic duct dilatation findings on computed tomography (CT) ($p=0.036$ and $p<0.001$, respectively), and those who only underwent a small number of tract dilatation sessions

($p=0.003$). In the multivariate analysis, older age ($p=0.001$, odds ratio [OR]=1.078), a CT finding of non dilated intrahepatic duct ($p<0.001$, OR=6.061), and a small number of tract dilatation sessions were independent factors for predicting PTCS-related complications ($p=0.015$, OR=2.488).

4. Risk factors for complications in patients who underwent serial tract dilatations

Serial tract dilatations were performed in 95 patients (44.8%), but this did not affect the rate of complications ($p=0.126$). Patients were divided into two groups, first according to the number of tract dilatation sessions (2 vs. ≥ 3),

Table 3. Risk factors for PTCS-related complications

Risk factor	Univariate analysis			Multivariate analysis		
	Patients with complications (n=32)	Patients without complications (n=180)	p-value	Odds ratio	95% confidence interval	p-value
Median age (years)	70 (50-85)	63.5 (16-88)	<0.001	1.078	1.032-1.125	0.001
Male	16 (50.0)	96 (53.3)	0.728			0.940
Initial diagnosis						
Intrahepatic duct stone	12	99	0.068			0.180
Extrahepatic duct stone	12	45	0.142			0.211
Benign stricture of the bile duct	2	16	1.000			0.544
Bile duct carcinoma	3	12	0.706			0.856
CT finding						
Liver cirrhosis	6	12	0.036			0.064
Focal atrophy of liver parenchymal	5	10	0.056			0.095
Non-dilated Intrahepatic duct	11	19	<0.001	6.061	2.272-16.129	<0.001
Access hepatic duct						
Right anterior	0	7	0.598			0.258
Right posterior	19	124	0.290			0.387
Left lateral	13	49	0.125			0.183
Serial dilatations	10 (31.3)	85 (47.2)	0.094			0.167
Mean tract dilatation sessions	1.3 (0.6)	1.6 (1.5)	0.003	2.488	1.198-5.181	0.015
Mean tract maturation time (days)	12.5 (3.8)	14.6 (4.9)	0.214			0.315
Mean PTCS sessions	3.0 (1.6)	2.8 (2.2)	0.513			0.688
Therapeutic PTCS	27 (84.4)	150 (83.3)	0.884			0.695
EHL or balloon dilatation	22 (68.8)	136 (75.6)	0.416			0.507

Values are presented as range or median (range) or number (%).

PTCS, percutaneous transhepatic cholangioscopy; CT, computed tomography; EHL, electrohydraulic lithotripsy.

and subsequently according to the mean interval between sessions (≤ 3 days vs. > 3 days). In this subgroup, multiple dilatations (≥ 3 sessions) did not affect the occurrence of PTCS-related complications (0% vs. 28.2%, $p=0.061$), whereas short intervals between session (≤ 3 days) were associated with PTCS-related complications (90.0% vs. 31.8%, $p=0.001$) (Table 4).

DISCUSSION

The overall incidences of complications and mortality rates associated with PTCS have been reported to be 6–17% and 0–0.6%, respectively, in previous studies.^{6,7,11–14} In the current study, the incidence of complications during the entire PTCS procedure was 15.1% and there were no deaths. The incidence of complications was higher during the preparatory stage than during the PTCS sessions (9.4% vs. 5.7%). In other, previous studies, complications have also been found to occur more frequently during the preparatory stage (including PTBD, tract dilatation, and tract maturation) than during the PTCS stage.^{5,10,11,15} Accordingly, our findings agree with the results of previous studies. In the current study, however, complications were not categorized as mild or severe because of the ambiguity of this definition.

The incidence of complications per PTCS session was 2.0% in our study. One other study reported an incidence of 6.9% (58/848 sessions), making our results quite low by comparison.¹¹ This difference could be explained by the higher proportion of cases with serial tract dilatations (≥ 2 sessions, 44.8% vs. 1.8%) and the longer tract maturation time (mean: 14.3 days vs. 9.5 days) in the current study.¹¹ Many other centers have reported

the use of serial dilatation and long maturation times to minimize complications.^{6–10} In our study, complications occurred less frequently in patients who underwent serial tract dilatations (10.5%, 0.5% per PTCS session), although the difference was not statistically significant ($p=0.094$).

Furthermore, maturation time did not affect the rate of complications ($p=0.214$). Common PTCS-related complications include hemobilia, cholangitis, and biliary tract perforations. In our study, cholangitis, bile duct injury, and hemobilia were the common complications. Cholangitis occurred more frequently during the preparatory stage than during the PTCS stage (10 cases vs. four cases), but bile duct injury was more common during the PTCS stage (two cases vs. four cases). Pancreatitis occurred during the preparatory stage in two cases. Although significant pain had been a common complication in some previous studies, this was well controlled by analgesic use in our study and did not prolong hospitalization or warrant the use of additional interventions.^{11,13} It is also noteworthy that, in contrast to earlier studies, we did not focus on any particular disease, and our findings therefore provide a more representative and generalized picture of PTCS.

Of the investigated patient characteristics, age was the only significant independent risk factor. Comorbidities generally become more common with increasing age, so this finding is not unexpected. Nonetheless, our study provides the first statistically significant evidence of this effect for PTBD-related complications. Complications occurred in four cases among patients aged 16–59 years (4/68, 5.9%), nine cases among patients aged 60–69 years (9/61, 14.8%), 16 cases among patients aged 70–79 years (16/65, 24.6%), and three cases

Table 4. Subgroup analysis of patients who underwent serial tract dilatations

	Patients with complications (n=10)	Patients without complications (n=85)	Odds ratio (95% confidence interval)	p-value
Tract dilatation sessions			1.16 (1.06–1.28)	0.061
2 sessions (%)	10 (100)	61 (71.8)		
≥ 3 sessions (%)	0	24 (28.2)		
Mean tract dilatation interval			19.23 (2.33–166.67)	0.001
≤ 3 days (%)	9 (90.0)	27 (31.8)		
> 3 days (%)	1 (10.0)	58 (68.2)		

among patients aged 80–88 years (3/18, 16.7%).

The results of initial abdominal CT are checked for patients with biliary disease at almost all centers. Initial abdominal CT is useful diagnostic test and can be considered to estimate complication risks. In patients with a non-dilated intrahepatic duct, access by PTBD was comparatively difficult, although one previous study reported a 90% success rate.¹⁶ Although PTBD is successful, in the tract dilatation and PTCS stage, narrow bile ducts make dilatation using a Foley catheter and the introduction of a scope difficult. Hence, several dilatation sessions and a long maturation period are required. We investigated the relationship between CT findings (liver cirrhosis, focal atrophy, and intrahepatic duct dilatation) and the incidence of complications. Before PTCS, all of the patients enrolled in our study were assessed via abdominal CT. Liver cirrhosis was diagnosed by CT alone, and not clinically. In the multivariate analysis, intrahepatic duct dilatation on CT was significantly associated with the incidence of complications. Thirty patient had non-dilating intrahepatic duct on CT, of whom 11 experienced complications (preparatory stage: 6; PTCS stage: 5). The complications were as follows: four cases of bile duct injury, two cases of cholangitis, two cases of hemobilia, and one case of hepatic artery injury.

A previous study reported that liver cirrhosis (as clinically diagnosed) did not influence the incidence of PTCS-related complications, and that non-dilated bile ducts (as assessed via CT) were not significantly associated with the complication rate in patients undergoing PTBD.¹¹ However, to date there has been no report concerning the relationship between CT findings and PTCS-related complication; our results are significant in this regard. Based on previous studies, we expected that rapid tract dilatation would affect the complication rate.¹⁰ Rapid tract dilatation would mainly influence complications in terms of the tract dilatation interval and number of tract dilatation sessions. We expected that serial dilatations (≥ 2 sessions) would decrease the incidence of complications. Yet, even though patients with serial dilution tended to have a lower incidence of complications, this result was not statistically significant. The number of tract dilatation sessions (1–4 sessions) was an independent factor for predicting the PTCS-

related complications rate. We considered that several biliary tract dilatations using Foley catheters in a stepwise manner could have decreased the incidence of complications in our study. To verify the relationship between the tract dilatation interval and the risk of complications, a subgroup analysis was performed for patients with a serial tract dilatation. We found that an interval of ≤ 3 days was associated with a higher complication rate.

In a previous study, complications and mortality were significantly reduced by dilatation of the biliary tract in two sessions with a 3-day interval, followed by tract maturation for 6 days.¹⁰ However, that study only enrolled a small group of patients, and the enrolled patients had only undergone EHL for common bile duct or intrahepatic duct stones. Accordingly, the factors that influenced the results (e.g., number of dilatation sessions, tract dilatation interval, and tract maturation time) could not be determined. In our study, we sought to determine which specific factors affected the incidence of complications, and therefore analyzed each factor's relationship with rapid tract dilatation and tract maturation time. Our result will be helpful for the creation of a preparatory protocol.

In a previous study, EHL or balloon dilatation was associated with the incidence of complications and the complication rate was higher during the first session of PTCS than during the second or subsequent sessions.¹¹ On the other hand, PTCS-related procedures (such as EHL and balloon dilatation) did not affect the incidence of PTCS-related complications in the present study. Further, of the 12 patients who developed complications at the PTCS stage, complications had only occurred in seven patients after the first session. Nevertheless, the study group was small and the results were not statistically significant. Moreover, the access hepatic duct (right anterior, right posterior, or left lateral), procedure type (diagnostic or therapeutic), and number of PTCS sessions did not affect the complication rate, either.

Our study involved only a single center and had the retrospective nature. It could have introduced some selection bias. However, because the procedure was performed by only two experienced endoscopists and radiologists, technique-related bias was minimized. Furthermore, relatively more patients were

enrolled than in previous studies.^{7,10,17} In conclusion, although PTCS is relatively safe, complications can occur at each stage. Patient age and CT findings should be considered to determine the risk of complications. Furthermore, stepwise preparation may help to control the number of tract dilatations and the interval between tract dilatations may help to reduce the risk of complications. Careful preparation is essential in high-risk groups of patients who are older or who have liver cirrhosis or non-dilated intrahepatic ducts on CT. We recommend three or more stepwise tract dilatations and a long interval between tract dilatations (>3 days) in these groups.

요약

배경/목적: 경피경간담도경 검사(PTCS)는 진단과 치료에 널리 사용되고 있다. PTCS 관련 합병증(담관염, 담관천공, 혈액담즙증)은 드물지 않게 발생한다. 하지만 PTCS와 관련된 합병증의 위험인자에 대한 정보는 제한적이다. 따라서 본 연구에서는 이러한 PTCS와 관련된 합병증의 위험인자를 조사하고자 한다.

방법: 2006년 1월부터 2014년 10월까지 3차 의료기관에서 PTCS를 시행한 232명의 환자를 대상으로 연구하였다. 후향적으로 분석하여 최종 212명의 환자가 등록되었다. 환자들은 합병증이 발생한 그룹과 발생하지 않은 그룹으로 나누어 분석하였다.

결과: 112명의 남성과 100명의 여성으로 구성되었으며, 평균 나이는 64.5세였다. 212명의 환자 중 32명(15.1%)에서 합병증이 발생하였고, 담관염(14건, 6.2%), 담관손상(6건, 2.8%), 혈액담즙증(2건, 0.9%) 등이 발생하였다. 단변량 분석에서 고령, 경로 확장을 여러 번 하지 않은 경우, CT에서 간경화가 있거나 간내담관이 늘어나 있지 않은 경우 등은 PTCS와 관련된 합병증이 증가하였다. 다변량 분석에서는 고령과 경로 확장을 여러 번 하지 않은 경우 그리고 CT에서 간내담관이 늘어나 있지 않은 경우가 PTCS와 관련된 합병증을 예측할 수 있는 인자였다. 경로 확장을 2번 이상에 걸쳐서 시행한 환자는 95명(44.8%)이며, 합병증에는 영향을 주지 않았다. 하위그룹 분석에서는 경로 확장 간의 간격이 3일 이하인 경우, PTCS와 관련된 합병증과 관련이 있었다.

결론: 고령의 환자와 CT에서 늘어나 있지 않은 간내담도를 가진 환자에서는 시술 시 주의 깊게 시술해야 한다. 단계적인

경로 확장과 3일 이상의 긴 간격이 PTCS 관련 합병증을 줄이는데 도움이 될 수 있다.

국문 색인: 경피경간담도경, 합병증, 위험인자

Conflicts of Interest

The authors have no financial conflicts of interest.

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REFERENCES

1. Nimura Y, Kamiya J. Cholangioscopy. *Endoscopy* 1998;30:182-188.
2. Neuhaus H, Hagenmüller F, Griebel M, Classen M. Percutaneous cholangioscopic or transpapillary insertion of self-expanding biliary metal stents. *Gastrointest Endosc* 1991;37:31-37.
3. Lee SK, Seo DW, Myung SJ, et al. Percutaneous transhepatic cholangioscopic treatment for hepatolithiasis: an evaluation of long-term results and risk factors for recurrence. *Gastrointest Endosc* 2001;53:318-323.
4. Kim JH, Lee SK, Kim MH, et al. Percutaneous transhepatic cholangioscopic treatment of patients with benign bilio-enteric anastomotic strictures. *Gastrointest Endosc* 2003;58:733-738.
5. Chen MF, Jan YY. Bacteremia following postoperative choledochofiberscopy-a prospective study. *Hepatogastroenterology* 1996;43:586-589.
6. Nimura Y, Shionoya S, Hayakawa N, Kamiya J, Kondo S, Yasui A. Value of percutaneous transhepatic cholangioscopy (PTCS). *Surg Endosc* 1998;2:213-219.
7. Ponchon T, Genin G, Mitchell R, et al. Methods, indications, and results of percutaneous choledochoscopy. A series of 161 procedures. *Ann Surg* 1996;223:26-36.
8. Yeh YH, Huang MH, Yang JC, Mo LR, Lin J, Yueh SK. Percutaneous trans-hepatic cholangioscopy and lithotripsy in the treatment of intrahepatic stones: a study with 5 year follow-up. *Gastrointest Endosc* 1995;42:13-18.
9. Huang MH, Chen CH, Yang JC, et al. Long-term outcome of percutaneous transhepatic cholangioscopic lithotomy for hepatolithiasis. *Am J Gastroenterol* 2003;98:2655-2662.
10. Bonnel DH, Liguory CE, Cornud FE, Lefebvre JF. Common bile duct and intrahepatic stones: results of transhepatic electrohydraulic lithotripsy in 50 patients. *Radiology* 1991;180:345-348.
11. Oh HC, Lee SK, Lee TY, et al. Analysis of percutaneous transhepatic cholangioscopy-related complications and the risk factors for those complications. *Endoscopy* 2007;39:731-736.

12. Hwang MH, Tsai CC, Mo LR, et al. Percutaneous choledochoscopic biliary tract stone removal: experience in 645 consecutive patients. *Eur J Radiol* 1993;17:184-190.
13. Winick AB, Waybill PN, Venbrux AC. Complications of percutaneous transhepatic biliary interventions. *Tech Vasc Interv Radiol* 2001;(3):200-206.
14. Burke DR, Lewis CA, Cardella JF, et al. Quality improvement guidelines for percutaneous transhepatic cholangiography and biliary drainage. Society of Cardiovascular and Interventional Radiology. *J Vasc Interv Radiol* 1997;8:677-681.
15. Maier M, Kohler B, Benz C, Körber H, Riemann JF. Percutaneous transhepatic cholangioscopy (PTCS)--an important supplement in diagnosis and therapy of biliary tract diseases (indications, technique and results). *Z Gastroenterol* 1995;33:435-439.
16. Funaki B, Zaleski GX, Straus CA, et al. Percutaneous biliary drainage in patients with nondilated intrahepatic bile ducts. *AJR Am J Roentgenol* 1999;173:1541-1544.
17. Choi JH, Lee SK. Percutaneous transhepatic cholangioscopy: does its role still exist? *Clin Endosc* 2013;46:529-536.