

# Visual characteristics of the papilla to estimate cannulation of the common bile duct – a pilot study

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**Objectives:** Performance of endoscopic retrograde cholangiography (ERC) depends mainly on the skills of the examiner, but also on anatomical variants. The aim of the study was to investigate patient- and papilla-related factors for the successful selective cannulation of the common bile duct (CBD). **Patients and methods:** 50 patients with a papilla with no prior sphincterotomy needing an ERC were enrolled. From a standardized description given by the endoscopist, criteria to characterize the papilla were analyzed. **Results:** Success was achieved in 92%. Cannulation time was 460 +/- 561 seconds on average. 70% of the papillae were mastered in 300 seconds or less. Concordance between endoscopists concerning descriptive variables was between 86% and 100%. The judgment of the endoscopist concerning expected difficulty was not significantly related to success, demonstrating the necessity of predictive parameters. Typical position of the duodenoscope and performance of precut were significantly related to success. The joint presence of a visible orifice and a typical position of the duodenoscope had a positive predictive value (PPV) of 96%. **Conclusions:** Endoscopists can rely on the joint presence of a visible orifice of the papilla and a typical position of the duodenoscope in X-ray to predict the success of ERC. (Zuber-Jerger I, Gelbmann CM, Kullmann F. Visual characteristics of the papilla to estimate cannulation of the common bile duct – a pilot study. *North Am J Med Sci* 2009; 1: 66-73).

**Keywords:** Endoscopic retrograde cholangiography, common bile duct, papilla.

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## Introduction

Endoscopic retrograde cholangiography is an important tool in diagnosis and therapy of benign and malignant disorders of the biliary tree. The selective cannulation of the common bile duct is a difficult procedure, the success of which mainly depends on the skills of the examiner but also on the anatomical variants and the underlying illnesses.

Since selective cannulation of the common bile duct can be difficult, multiple strategies have been developed to overcome the situation: different papillotome instead of the standard catheter, precut papillotomy using precut needle knives or precut papillotomy, transpancreatic papillary septotomy, and stenting of the pancreatic duct [1-6]. Complicated cannulation is discussed as a relevant determinant for post-ERCP-pancreatitis [7, 8, 9]. A number of pharmacological and mechanical strategies have been devised to avoid this severe complication [10-23]. Diclofenac reduced the incidence of post-ERCP-pancreatitis in a Scottish cohort [23]. Other drugs have not been proven valid: the results of giving allopurinol, ulinastatin, somatostatin, beta-carotene, lidocaine, heparin, NK 1 receptor antagonist, corticosteroids and interleukin 10 to avoid post-ERCP-pancreatitis were disappointing [12-22]. There are more promising results for the placement of a protective pancreas stent [10].

Though a lot of strategies have been developed to facilitate selective cannulation of the common bile duct and to prevent the major complication of difficult ERCs, little is known about the factors responsible for the difficulty to gain access to the common bile duct. Many known fundamental factors have been passed along from trainers to trainee over the years which are probably correct but have not been validated formally in a study. There is common agreement concerning some factors that are considered difficult for the accessibility of a papilla, though discussed controversially, duodenal diverticula are considered such a factor [3, 24].

Thus, the aim of our study was to identify relevant patient- and papilla-related factors facilitating or complicating access to the common bile duct.

## Patients and Methods

*Design of the study, patients and data collection* 50 (27 female, 23 male) consecutive adults with a mean age of 62.76±13.35 (min 32, max 83) were included in the pilot study performed in 2005 in the endoscopy unit of the University Hospital of Regensburg. Patients were eligible for the study if ERCP during the regular daily period of service was indicated and there was no prior sphincterotomy of the papilla. Patients with an altered

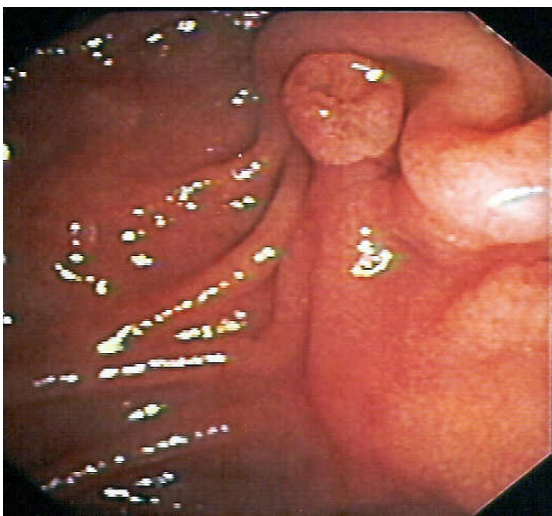
anatomical route to the papilla due to surgery, such as status after Billroth II, etc., were excluded.

The study was performed by two advanced endoscopists and a trainee. Every procedure was performed by only one examiner. Procedures were not randomized, since patients who had undergone an unsuccessful ERC in another hospital performed by an experienced endoscopist, had this study's procedure done by the advanced endoscopist. In 14 patients (28%) this was the case.

An attempt was either the successful cannulation of the CBD or an unsuccessful procedure. Cannulation technique was not standardized. It was the examiner's choice to begin with a standard catheter (6 French, not tapered) or a papillotome (triple lumen) with a terumo wire, but the examiner was forced to use both techniques before the procedure was unsuccessfully terminated. The decision to perform a precut was left to the examiner. After thirty minutes of unsuccessful maneuvers the first attempt was terminated. The duration of the second attempt was not limited. Its duration was left to the decision of the examiner.

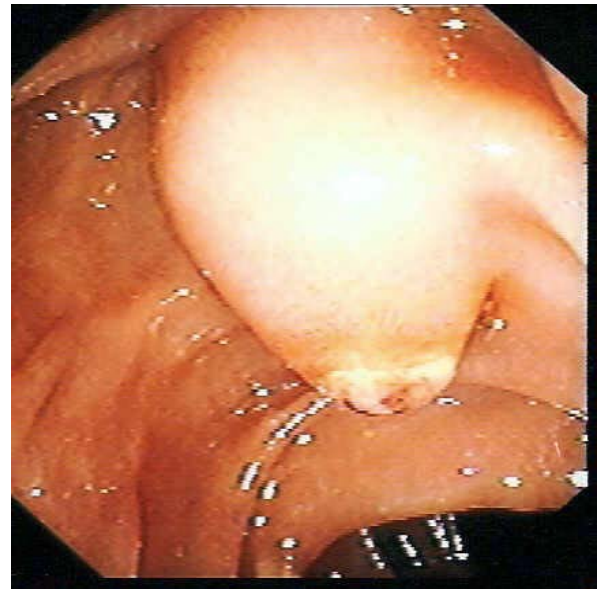
Basic patient characteristics (age, gender, height, weight, BMI, prior surgery and indication for ERCP) were collected in a database, the access to which was restricted to the authorized physician. Informed consent was obtained from the patients whose data were collected.

Basic papilla characteristics were documented in the same database. The papilla was photographed at the beginning of the examination. The common bile duct and pancreatic duct were documented by X-ray if contrasted. Cannulation time (interval between reaching ERCP-position after identification of papilla major and selective cannulation of the common bile duct) and the number of maneuvers with the standard catheter and/or the papillotome were documented by the endoscopy nurse. The necessity of a precut was documented, too. If necessary, precut was performed starting from the papillary orifice cutting upward.

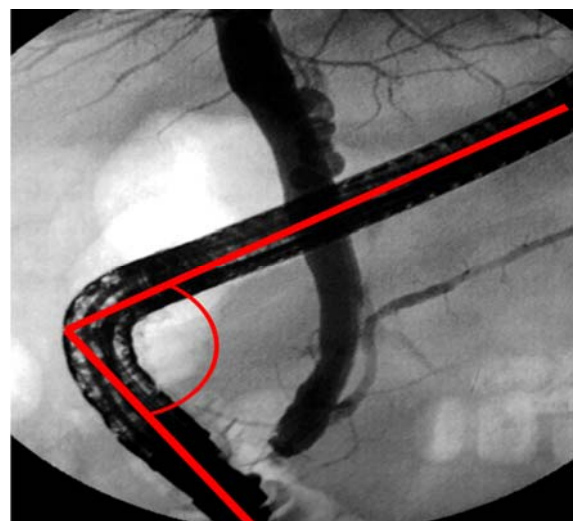


**Fig. 1** A big soft papilla of a 46 year-old male patient with chronic pancreatitis. Successful intubation with the standard catheter was performed after 10 s.

The endoscopists had to give a detailed description of the papilla. From this description the following criteria to characterize the local situation in front of the papilla were developed: size of the papilla (small/big) (Fig. 1) and height of the roof of the papilla (small/big) (Fig. 1); visibility of the orifice of the papilla (yes/no) (Figs. 1, 2); hardness when touched with the catheter (yes/no); position of the papilla in duodenum in X-ray (typical/atypical); position of the duodenoscope (typical/atypical); stability of the duodenoscope in position (stable/unstable); bleeding of the papilla when touched (yes/no); swelling of the papilla when touched (yes/no); morphology of the papilla (healthy/diseased) (Figs. 1, 2); visibility of bile stream (yes/no); the presence of diverticula (yes/no) and duodenitis (yes/no).



**Fig. 2** A prominent papilla obstructed by sludge in a 63 year-old female patient. Successful intubation with the papillotoma was performed after 300 s.



**Fig 3** "Typical position of the duodenoscope" was defined by the red angle.

The papilla was measured with open biopsy forceps with a diameter of 5 mm. A papilla with a diameter of less than 5 mm was considered small, otherwise big. The height of the

roof of the papilla was described as small when it was less than 5 mm, otherwise big.

The position of the papilla in the duodenum was considered atypical if it was hidden between swollen folds or displaced by diverticula, tumor or lipoma.

The parameter “position of duodenoscope” was defined by measuring the angle described in Figure 3. The position of the duodenoscope was described as typical if it was placed straight and the angle was between 90 and 135 degrees.

The procedures were performed by endoscopists with a varying level of training: two advanced endoscopists (experience in endoscopy more than eight years, ERCP more than five years) and one endoscopist-in-training (experience in endoscopy more than five years, ERCP one year). To test the endoscopists’ ability to identify a difficult papilla, the examiner was asked whether it would be easy or difficult after having placed the duodenoscope and having inspected the papilla before the first maneuver with the catheter.

The following classification of outcomes was used. Success and failure were defined in terms of the selective cannulation of the common bile duct during an attempt. If necessary, two attempts were made. Successful cannulation of the CBD in the first (second) attempt was defined as primary (secondary) success. In accordance, procedures were labeled as primary (secondary) failures in the first (second) attempt. Our primary endpoint was successful cannulation of the CBD in an attempt (“success/failure”). Our final endpoint was “final success/final failure” defined as successful cannulation of the CBD either in the first or in the second attempt, defined as “final success” or two unsuccessful procedures defined as “final failure” (Fig. 4).

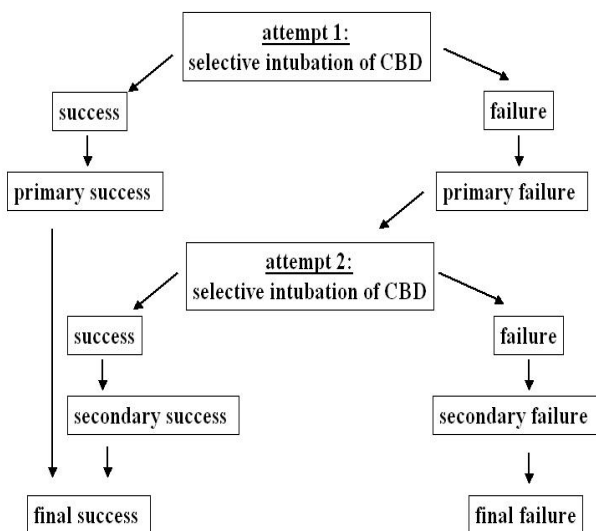


Fig. 4 Flow diagram to describe the definitions “primary/secondary success/failure”, “success/failure” and “final success/failure”.

**Statistical analysis**

For analyses, we used the statistics program SPSS (Chicago, Illinois). In order to check for significant

influences of the categorical variables on our categorical outcome variable (“success” versus “failure”) we used the chi-squared test employing Yates’s correction for continuity where appropriate. To compare the medians between two different groups, the Mann-Whitney test was used. Key variables provided by the bivariate analysis were further subjected to logistic regression analysis (SPSS). The logistic regression analyses were performed in a multivariate setting to measure the independent effects of factors after adjusting for the contributions of each of the other factors in the models. This investigation provided models predicting success and precut. A p-value of < 0.05 was defined as significant. The p-values for the bivariate statistical tests are not corrected for multiple testing because those tests were taken as exploratory. The subsequent multivariate logistic regression analyses were considered the main definitive result as they determined those variables independently associated with the outcomes of interest after adjusting for the contributions of the other variables. Correction by Bonferroni’s method was applied.

**Results**

A total of 50 patients with native papilla and normal anatomical routes to the papilla were examined in two months. Patients’ characteristics, including sex, age, weight, height, BMI, indications for ERCP and diagnosis, are given in table 1. Of 55 procedures, 45 (82%) were successful and 10 (18%) failed.

Table 1 Patients’ characteristics, indications and diagnosis (n = 50)

Patients’ characteristics	
sex (m/f)	23/27
age median (min/max) (y)	65(32/83)
weight median (min/max) (kg)	75(41/102)
height median (min/max) (cm)	168(153/189)
BMI median (min/max)	22(18/34)
Indication (%)	
painless jaundice	11
CBD dilatation in sonography	11
suspicion of choledocholithiasis in sonography	49
necessity to obtain a histology of inoperable pancreatic cancer	9
abdominal pain with a history of chronic pancreatitis	9
elevated liver enzymes	11
Diagnosis (%)	
choledocholithiasis	20
cholecystolithiasis	7
primary sclerosing cholangitis	5
cholangitis	2
stenosis of anastomosis after liver transplantation	4
chronic pancreatitis	9
CBD stenosis	18
stenosis of the pancreatic duct	11
stenosis of the papilla	2
duodenitis	2
no pathology	11
malignant/benign disease	17/33

CBD: common bile duct; BMI: *body mass index*. \* It must be considered that some procedures were done because of more than one indication, e.g., painless jaundice and dilatation of common bile duct in sonography. Additionally, some procedures led to more than one

diagnosis, e.g., cholecystolithiasis and choledocholithiasis or cholangitis and stenosis of the common bile duct.

**Table 2** Patients (A-E) examined twice by different endoscopists (1-3)

Patient	Examiner	Outcome of an attempt	Outcome	Discordant var/ No. var	Description of discordant var
A	ET 1	primary failure			
	AE 1	secondary failure	Final failure	0/14	
B	AE 1	primary failure			
	AE 2	secondary failure	Final failure	2/14	precut, judgment
C	ET 1	primary failure			
	AE 1	secondary success	Final success	1/14	precut
D	ET 1	primary success	Final success		
	AE 1	primary success	Final success	0/14	
E	ET 1	primary failure			
	AE 1	secondary success	Final success	1/14	stability of position

AE: advanced endoscopist; ET: endoscopist in training; var: variables

**Table 4** Logistic regression with the dependent variable "success" and the independent key variables "visibility of the orifice" and "position of duodenoscope in X-ray".

	Predicted success	Predicted failure	
<b>Success</b>	43	2	positive predictive value 96%
<b>Failure</b>	7	3	negative predictive value 70%
	sensitivity 90%	specificity 71%	

Significance of the model p < 0,001  
 Visibility of orifice p = 0,200  
 Position of duodenoscope in X-ray p < 0,001

Log-Likelihood 33,351; Nagelkerkes R-square 0,473; Cox and Snell R-square 0,290. The model was constructed with a constant.

24 procedures were done by the trainee and 31 by advanced endoscopists. 30 were done by advanced endoscopist 1 and only one by advanced endoscopist 2. In this one instance, the first procedure had already been done by advanced endoscopist 1 and was a primary failure. So the second procedure was performed by advanced endoscopist 2. Of the 31 procedures done by advanced endoscopists, 25 (81%) were successful and six failed (19%); of the 24 procedures done by the trainee, 20 were successful (83%) and four failed (17%).

Primary success was achieved in 44 patients (88%). Five patients were examined twice by two different endoscopists (Table 2). One patient with primary sclerosing cholangitis and a native papilla was successfully examined twice due to recurrent intrahepatic

strictures (Table 2, patient D). Secondary success after primary failure was achieved in two patients (4%) (Table 2, patients C, E). Final success was thus achieved in 46 patients (92%). Failure occurred in four patients (8%). Two of these patients were examined once (primary failure) (4%) and two twice (primary, secondary and final failure) (4%) (Table 2, patients A, B).

In ten procedures only the papillotome was used. In 13 procedures only the standard catheter was used. In 32 procedures both cannulation techniques were used.

Precut was needed in eight examinations (15%) and in seven patients (14%). In two instances, precut was performed in the first attempt leading to primary success, and in another it was performed in the second attempt

leading to secondary success. In three instances, precut was performed during the first attempt leading to secondary success after primary failure. In one instance, precut was performed unsuccessfully during the first and the second attempt, leading to final failure. In the seven patients with precut, final failure occurred once (14%) and final success six fold (86%).

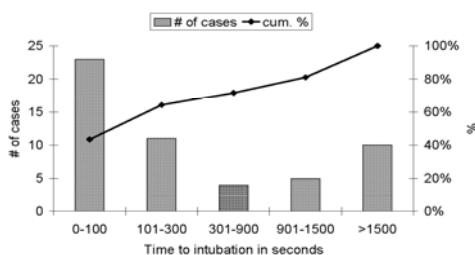
The two groups with success and failure were compared using the criteria developed to characterize the papilla and by means of patient- and endoscopist-related criteria (Table 3). Judgment of the expected difficulty according to the advanced endoscopist was weakly related to success of the procedure, and judgment of the trainee was not significantly related to success. However, the determinants "position of the duodenoscope" and "precut" were found to differ significantly between the two groups (Table 3). Correction by Bonferroni's method would not have removed significance from any of the bivariate test results.

Logistic regression models were created in order to predict successful cannulation. Our preferred model is shown in table 4. The joint presence of a typical position of the duodenoscope and a visible orifice predicts success with a positive predictive value (PPV) of 96%. These predictive models were chosen to include non-significant factors in the multivariate logistic regression analyses to better gauge the effect of the significant factor (position of the duodenoscope) after adjusting for the contributions of the included non-significant factors and to increase the predictive accuracy of the models.

Concordance between endoscopists concerning variables was between 86% and 100% (Table 2). Discordant factors were the performance of precut, the judgment of the endoscopist and the ability of the second examiner to reach a stable position of the duodenoscope (Table 2).

Cannulation time of the common bile duct ranged from 10 s to 1500 s and was 460 +/- 561 s on average.

Figure 5 shows that 70% of successful selective cannulations of the common bile duct were achieved within 300 s or less. 80% were achieved in up to 900 s. Precut was usually performed after unsuccessful maneuvers for 1500 s (one exception).



**Fig. 5** All cases were categorized in 5 groups of increasing time to intubation. The number of cases is demonstrated as bars. Cumulated percentage of increasing time to intubation in seconds is shown as a line.

The choice of the cannulation technique (standard catheter alone; papillotome alone; or a combination of both) did not have significant association as a predictive value for success or failure.

**Table 3** Comparison of the two patient groups with successful (success) or failed (failure) selective intubation of the common bile duct.

Variable	Success	Failure	p-value
interventions (n)	45	10	
age mean (SD) y	62 (14)	63 (13)	0,885
gender (male/female)	21/24	4/6	0,702
BMI mean (SD) kg/m <sup>2</sup>	25 (3)	27 (5)	0,129
body height mean (SD) cm	169 (9)	170 (10)	0,981
body weight mean (SD) kg	71 (19)	78 (12)	0,138
prior surgery (yes/no)	22/23	4/6	0,798
size of papilla (big/small)	23/22	5/5	0,638
size of papilla-roof (big/small)	23/22	8/2	0,213
visibility of the orifice (yes/no)	30/15	5/5	0,256
hardness (hard/soft)	11/34	4/6	0,243
position of duodenoscope in X-ray (typical/atypical)	39/6	2/8	<0,001
position of papilla (typical/atypical)	36/9	5/5	0,489
stability of duodenoscope (stable/instable)	38/7	7/3	0,284
swelling of papilla (yes/no)	7/38	2/8	0,714
bleeding of papilla (yes/no)	2/43	2/8	0,087
morphology of papilla (healthy/diseased)	35/10	6/4	0,243
visibility of bile stream (yes/no)	26/19	4/6	0,292
presence of diverticula (yes/no)	5/40	3/7	0,125
presence of duodenitis (yes/no)	10/35	3/7	0,601
experience of endoscopist (AE/ET)	21/24	5/5	0,760
judgment of endoscopist (easy/difficult)	20/25	2/8	0,154
judgment of trainee (easy/difficult)	13/7	2/2	0,609
judgment of advanced endoscopist (easy/difficult) *	12/13	5/0	0,530
performance of precut (no/yes)	42/3	5/5	<0,001

SD: standard deviation; AE: advanced endoscopist; ET: endoscopist in training.

Note: As indicated in the text, five patients were examined twice. Thus, the total number of examinations is higher than the number of patients documented in Table 1. The total number of examinations done by trainee and advanced endoscopist are 54 because a second advanced endoscopist did the second examination after the occurrence of primary failure by the advanced endoscopist.

## Discussion

Successful performance of diagnostic and therapeutic endoscopic retrograde cholangiography (ERC) requires skillful use of the duodenoscope and accessories. Prospective evaluation of ERC-training demonstrates a learning curve [25]. The 85% level of selective cannulation is reached for the common bile duct after 100 procedures [25]. Based on a questionnaire filled in by 69 American gastroenterology fellows, a cannulation rate of 80% was estimated after 180 ERCPs [26]. The same study showed that the majority of graduating fellows do not achieve this success rate during training although they intend to perform unsupervised ERCP afterwards. In Europe, the situation is comparable. So there is a necessity to improve ERCP training in Europe and in the US. Since

there is not an unlimited number of procedures, selection of papillae for different states of training may help to achieve better training results and optimize organization of endoscopy units.

Although many publications in the last years focused on strategies facilitating selective cannulation of the common bile duct and on prevention of post-ERCP pancreatitis [1-23, 27, 28], nothing has been published so far describing patient- and papilla-related factors that might influence the accessibility of the common bile duct. Even the important prospective training studies mentioned above [25, 26] did not differentiate between the “easy” and the “difficult” papilla. Our hypothesis was that variables related to the anatomy of the patient and the papilla can be used to predict success or failure. Comparable attempts have already been made in colonoscopy. For example, cecal cannulation is prolonged in females and in patients with lower body mass index [29, 30, 31].

Our bivariate analysis showed that the judgment of the endoscopist regarding level of difficulty after placing the duodenoscope in the duodenum and inspecting the papilla, but before any maneuver with the catheter was done, was not related to success. This confirms our hypothesis that objective patient-related and papilla-related variables are necessary to predict successful selective cannulation of the common bile duct.

It turned out that the performance of precut and the typical position of the duodenoscope was significantly related to success. Since it was our aim to find a predictive model with variables that can be determined within the first minute of the examination, the performance of precut—usually done after 25 minutes—was not considered a helpful parameter. The combination of a visible orifice and a typical position of the duodenoscope turned out to be the best model with a PPV of 96%.

Since there is no evidence in the literature [3, 24] but common sense that duodenal diverticula complicate the access to the common bile duct, we checked our data and did not find a direct association between failure and the presence of duodenal diverticula. But this might be due to the limited number of patients included in the study.

Another factor influencing success is the selection of the technique [5, 27, 28]. With standard catheters, selective bile duct cannulation can be routinely achieved in most but not in all cases. Repeated unsuccessful attempts may result in trauma of the papilla. Sphincterotomes can be used as devices to perform selective cannulation as well. A study from Schwacha et al. reported a primary success rate of 85% with the papillotome compared with 62% using the standard catheter [27]. Complication rates did not differ. The authors considered the stiffness of the papillotome allowing better directional control in cases of difficult cannulation but did not specify the factors relevant for difficult cannulation. Goldberg et al. report a success rate of 97.4% that was achieved by means of a pancreatic stent to facilitate the access to the common bile duct [5]. In our cohort, a comparison of standard catheter and papillotome showed no influence on success or failure rates. But since

there was no standardized protocol to cannulate, we consider this data not really interpretable.

Little is published about the time needed for cannulation of the common bile duct. In a study comparing precut papillotomy and persistent maneuvers with the standard catheter or the papillotome, a cannulation of the bile duct was considered difficult if cannulation was not successful after 12 minutes. After this time, precut was considered [4]. In our cohort, 70% of the successfully intubated common bile ducts without precut were finished after five minutes. To achieve a success rate of 80%, a cannulation time of 15 minutes was necessary. The performance of precut was one of two highly significant variables predicting success. This suggests that precut should be done after 15 minutes. But precut is considered as an independent predictor of post-ERCP pancreatitis [32]. On the other hand, a prolonged difficult cannulation increased the risk of post-ERCP as well [7, 8]. In our cohort there was no complication at all. But since complication rate of precut can be high—between 10% and 20% in the literature [4, 7, 8]—precut remains the option of last choice.

The failure rate described in literature varies between 3% [5] and 37% [27, 33]. Our failure rate may have been increased by the developing experience of the trainee. The missing difference between the failure rates of the trainee and the advanced endoscopist is explained by the schedule of the study. Admissions from other hospitals having had unsuccessful ERC by an experienced endoscopist had their procedures performed by the advanced endoscopist, so there was a bias.

In conclusion, our data suggest that the typical position of the duodenoscope is the single most important factor determining success. The combination of two variables—typical position of duodenoscope and visible orifice—has a positive predictive value of 96%. These variables can be evaluated easily at the beginning of the procedure and can be used by the examiner to quickly predict success. This information might help to improve organization in endoscopy units with endoscopists in different states of training. Further studies in a larger collective with a higher interobserver variability should confirm these results.

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