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Editorial Board Member of World Journal of Gastrointestinal Endoscopy, Andreas Sieg, MD, PhD, Assistant Professor, Department of Gastroenterology, Practice of Gastroenterology, 69115 Heidelberg, Germany

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WJGE covers topics concerning gastroscopy, intestinal endoscopy, colonoscopy, capsule endoscopy, laparoscopy, interventional diagnosis and therapy, as well as advances in technology. Emphasis is placed on the clinical practice of treating gastrointestinal diseases with or under endoscopy.

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Editorial Office

Xiu-Xia Song, Director
World Journal of Gastrointestinal Endoscopy
Baishideng Publishing Group Inc
8226 Regency Drive, Pleasanton, CA 94588, USA
Telephone: +1-925-2238242
Fax: +1-925-2238243
E-mail: editorialoffice@wjgnet.com
Help Desk: http://www.f6publishing.com/helpdesk
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Analysis of the risk factors for severity in post endoscopic retrograde cholangiopancreatography pancreatitis: The indication of prophylactic treatments

Hiroshi Matsubara, Fumihiro Urano, Yuki Kinoshita, Shozo Okamura, Hiroki Kawashima, Hidemi Goto, Yoshiki Hirooka

AIM
To determine the risk factors of severe post endoscopic retrograde cholangiopancreatography pancreatitis (sPEP) and clarify the indication of prophylactic treatments.

METHODS
At our hospital, endoscopic retrograde cholangiopancreatography (ERC) was performed on 1507 patients from May 2012 to December 2015. Of these patients, we enrolled all 121 patients that were diagnosed with post endoscopic retrograde PEP. Fourteen of 121 patients diagnosed as sPEP were analyzed.

RESULTS
Forty-one patients had contrast media remaining in the pancreatic duct after completion of ERC. Seventy-
INTRODUCTION

Post endoscopic retrograde cholangiopancreatography pancreatitis (PEP) is a typical endoscopy-related accident in the biliopancreatic field, and there are many reports on its risk factors. Many researchers reported methods to prevent PEP. However, treatment to prevent PEP in all endoscopic retrograde cholangiopancreatography (ERCP) patients is not recommended in consideration of accidents caused by the addition of preventive techniques, adverse reactions of preventive drug administration, and cost. Since PEP is a predictable pathology, and if discovered and appropriately treated early many patients rapidly recover. However, some cases aggravate to a severe state and become fatal. Therefore, it is important to identify factors leading PEP to a severe state, and when such risk factors are observed, therapeutic intervention, such as the addition of preventive techniques and preventive drug administration, should be performed. The objective of this study was to retrospectively clarify risk factors aggravating PEP to a severe state and determine the indications to prevent and treat PEP.

MATERIALS AND METHODS

Patients

Between May 2012 and October 2015, 1507 patients were examined by ERCP at our hospital. PEP was diagnosed in 121 of them (8.02%), and 14 of them were diagnosed with severe PEP (sPEP) and analyzed. Patients accompanied by acute pancreatitis at the time of undergoing ERCP were excluded (Figure 1). The study was performed in conformity with the Declaration of Helsinki and registered at UMIN-CTR (000022086).

ERCP procedure

For ERCP, a side-view duodenoscope was used. The endoscope used was JF260V (Olympus Medical, Tokyo, Japan). For the cannula, contrast medium, a 0.035-inch V system (Olympus Medical, Tokyo, Japan) was used. For the guide wire, Jagwire (0.035inch; Boston scientific Corporation, Tokyo, Japan) or Visigride (0.025 inch; Olympus Medical, Tokyo, Japan) was used. Replacement fluid (2000 mL) was intravenously administered within 24 h before and after ERCP. Patients received protease inhibitor (nafamostat mesilate, 20 mg/d) and prophylactic antibiotic administration (sulbactam/cefoperazone, 2 g/d) for 2 d. Vitals were checked 3 h after completion of ERCP. For patients in whom abdominal pain developed before this, 25 or 50 mg of indomethacin suppositories were administered. When PEP was diagnosed, sufficient fluid replacement including protease inhibitor and antibiotics was continued so as to maintain the urinary volume at 1 mL/min under monitoring of circulatory dynamics.

Diagnoses and grading of PEP

PEP was diagnosed following the Cotton’s criteria: When abdominal pain developed on the day following ERCP and the serum amylase level was 3 times or higher than the normal upper limit, the patient was diagnosed with PEP. sPEP was defined as PEP with 10 d or longer prolongation of inpatient treatment, hemorrhagic pancreatitis, phlegmon, and pseudocyst.

Risk factors for sPEP

Clinical data of PEP patients were retrospectively analyzed. One patients had abdominal pain within three hours after ERCP. These were significant differences for sPEP (P < 0.05). The median of Body mass index, the median time for ERCP, the median serum amylase level of the next day, past histories including drinking and smoking, past history of pancreatitis, sphincter of Oddi dysfunction, whether emergency or not, expertise of ERCP procedure, diverticulum nearby Vater papilla, whether there was sphincterotomy or papillary balloon dilation, pancreatic duct cannulation, use of intraductal ultrasonography enforcement, and transpapillary biopsies had no significant differences with sPEP.
extracted from their clinical records. As sPEP risk factors, age, gender, body mass index (BMI), past medical history including cigarette smoking and alcohol drinking and acute pancreatitis, the presence or absence of the sphincter of Oddi dysfunction (SOD), diverticulum nearby Vater papilla and common bile duct (CBD) diameter of patient with CBD stones, whether or not it was emergency ERCP, whether or not EST or EPBD was performed, pancreatography, the presence or absence of residual contrast medium in the pancreatic duct after completion of ERCP, the use of IDUS and transpapillary biopsy, treatment time, experience of operators, development of abdominal pain within 3 h after completion of ERCP, and serum amylase level, white blood cell count, and C-reactive protein on the day following ERCP were surveyed (Tables 1 and 2). The time from insertion to removal of a scope was defined as the ERCP treatment time. Experience of operators was defined based on the total and recent numbers of ERCP performed. Operators with a total number of ERCP performed of 200 or fewer and/or a recent number of ERCP performed of 40 or fewer per year were regarded as non-expert. Unfortunately, no study has examined role of sphincterotomy and number of pancreatic cannulation except our following conference paper.

**Statistical analysis**

In the univariate analysis, the difference between the two groups of categorical parameters were analyzed using Pearson’s χ² test. The Kruskal-Wallis test was used for continuous parameters. The stepwise logistic regression model (forward selection) was used to calculate the odds ratio (OR) with 95%CI. Significant predictors in the univariate analysis were then included in a forward stepwise multiple logistic regression model. All tests were two-sided and P values of < 0.05 were considered significant. Analyses were performed using IBM SPSS statistical software (version 21; SPSS Japan Inc., Tokyo, Japan).

**RESULTS**

**Patient characteristics in the PEP**

The median age of the 121 PEP patients was 76 (18-91) years old, and there were 64 male (52.9%) and 57 female (47.1%) patients. The median BMI was 21.2 (14.0-35.2) kg/m². Thirty-one and 42 patients were cigarette smokers and habitual alcohol drinkers, respectively. The past medical history was heart disease in 21 patients, diabetes in 24, chronic kidney disease in 41, malignant disease in 27, and acute pancreatitis in 2. SOD was suspected in 7. Diverticulum nearby Vater papilla was noted in 40. Forty-one patients had CBD stones (Table 3).

**Clinical data and ERCP intervention in the PEP**

ERCP was performed urgently in 17 patients. EST and EPBD were performed in 31 and 14 patients, respectively. Pancreatography was performed in 74 patients, and residual enhancement of the pancreatic duct was noted at completion of ERCP in 41 patients. IDUS and transpapillary biopsy were performed in 26 and 35 patients, respectively. The median treatment time was 50 (12-170) min. Experts and non-experts performed ERCP in 50 and 71 patients, respectively. Abdominal pain developed within 3 h after completion of ERCP in 71 patients. The median serum amylase level, WBC count, and serum CRP on the day following ERCP

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**Table 1** Characterization of patients with post endoscopic retrograde cholangiopancreatography pancreatitis

| Variables                                      | Mild-moderate PEP | Severe PEP |
|------------------------------------------------|-------------------|------------|
| Age (yr) (n = 121)                             | 73.7 (18-93)      | 76.5 (32-88) |
| Gender (n = 121)                               |                   |            |
| Male/female                                    | 57/50             | 7/7        |
| BMI (kg/m²) (n = 121)                          | 21.6 (13.97-35.20)| 23.2 (14.79-29.5) |
| Smoking status (n = 121)                       |                   |            |
| Non-smoker/Ex- or current smoker               | 83/24             | 7/7        |
| Drinking status (n = 121)                      |                   |            |
| Absent/present                                 | 67/40             | 12/2       |
| Past history (n = 121)                         |                   |            |
| Absent/present                                 | 31/76             | 4/10       |
| Malignant disease (n = 121)                    |                   |            |
| Absent/present                                 | 84/23             | 10/4       |
| History of pancreatitis (n = 121)              |                   |            |
| Absent/present                                 | 106/1             | 1/13       |
| SOD (n = 121)                                  |                   |            |
| Absent/present                                 | 101/6             | 1/13       |
| CBD diameter of patient with CBD stones (n = 41)| 70/37             | 11/3       |

PEP: Post endoscopic retrograde cholangiopancreatography pancreatitis; BMI: Body mass index; SOD: Sphincter of Oddi dysfunction; CBD: Common bile duct.

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**Figure 1** Patients’ flow chart. ERCP: Endoscopic retrograde cholangiopancreatography; PEP: Post endoscopic retrograde cholangiopancreatography pancreatitis.
were 1065 (83-3604) IU/mL, 8050 (3240-26320)/μL, and 2.1 (0.04-38.31) mg/dL, respectively (Table 4). No patients died during the study.

**Risk factors of sPEP**

On univariate analysis, residual enhancement of the pancreatic duct at completion of ERCP and development of abdominal pain within 3 h after completion of ERCP were significant risk factors of sPEP (Tables 3 and 4). On multivariate analysis, significant differences were noted in residual enhancement of the pancreatic duct (OR = 4.254, 95%CI: 1.238-14.616) and development of abdominal pain (OR = 10.41, 95%CI: 2.13-53.38), showing that these were independent risk factors of sPEP (Table 5).

**DISCUSSION**

It has been reported that the incidence of PEP in all patients examined by ERCP was about 3.5%, and PEP aggravated to a severe state (sPEP) in 0.4%. Therefore, the indication of ERCP should be carefully judged. It has become possible to refrain from performing diagnostic ERCP as low-invasive examination techniques, such as MDCT, MRI, and EUS, have improved. However, ERCP is still essential as a therapeutic measure to diagnose the advancement of biliary tract malignancy and obstructive disease of the pancreaticobiliary duct, and ERCP has to be inevitably performed although there is a risk of causing PEP. There are many previous reports on risk factors of PEP, but risk factors of sPEP are unclear. Generally admitted risk factors of PEP include female gender, pancreatic sphincterotomy, difficulty in cannulation, 3 times or more applications of ERP, ERP reaching the tail of the pancreas even if it was performed once, excess contrast pressure, contrast imaging of the pancreatic acinus, brushing pancreatic juice cytology, and SOD. These were risk factors of PEP, but not risk factors of sPEP in our study.

In our study, the residual contrast medium in the pancreatic duct at completion of ERCP was an independent risk factor of sPEP, suggesting that reduction of intraductal pressure of the pancreas at completion of ERCP may prevent sPEP, which may lead to a method to effectively avoid sPEP. Akashi et al compared groups with and without the addition of EST and observed that the incidence of sPEP was lower in the group with EST. They hypothesized that reduction of intraductal pressure of the pancreas by the addition of EST reduced the incidence of sPEP. However, EST may accidentally perforate the digestive tract and it is contraindicated for patients treated with oral antithrombin. Thus, not all patients should be treated with EST. On the other hand, Nakahara et al reported that when the pancreatic duct guide wire method is employed for a patient with difficult bile duct cannulation, pancreatic duct stenting should be performed even though EST was added. In addition, Ito et al reported that preventive pancreatic duct stenting contributes to reducing the incidence of PEP, excluding IPMN patients not accompanied by pancreatic duct dilatation in the pancreatic head. The European Society of Gastrointestinal Endoscopy Guideline and the American Society for Gastrointestinal Endoscopy Guideline recommend pancreatic duct stenting in patients with a risk factor, and Sofuni et al reported that the use of a spontaneous dislodgment pancreatic duct stent prevented PEP regardless of the presence or absence of a risk factor. However, the frequency of cannulation for stenting increases as a problem with preventive pancreatic duct stenting. We also consider that pancreatic duct stenting reported by many researchers, is an effective method to prevent PEP including sPEP, but no patients with pancreatic duct stenting were included in our study. The appropriate conditions for pancreatic duct stenting in ERCP patients have not been established, but, based on the results of our study, conduct of a large-scale clinical study on the addition of preventive EST and pancreatic duct

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**Table 2 Clinical data and endoscopic retrograde cholangiopancreatography intervention of patients with post endoscopic retrograde cholangiopancreatography pancreatitis**

| Variables                                      | Mild-moderate PEP (n = 107) | Severe PEP (n = 14) |
|------------------------------------------------|-----------------------------|-------------------|
| ERCP procedure                                 |                             |                   |
| Not emergency/emergency                         | 91/16                       | 13/1              |
| EST                                            | 29                          | 2                 |
| EPBD                                           | 12                          | 2                 |
| Pancreatography                                 |                             |                   |
| No/yes                                         | 38/69                       | 9/5               |
| Contrast media remained in the pancreatic duct |                             |                   |
| No/yes                                         | 75/32                       | 5/9               |
| IDUS                                           |                             |                   |
| No/yes                                         | 86/21                       | 9/5               |
| Transpapillary biopsies                         |                             |                   |
| No/yes                                         | 76/31                       | 10/4              |
| Time for ERCP procedure (min)                   |                             |                   |
| Median                                         | 50                          | 56                |
| (range)                                        | (12-170)                    | (26-150)          |
| Expertise of ERCP procedure                    |                             |                   |
| Not expert/expert                              | 62/45                       | 9/5               |
| Abdominal pain within three hours after ERCP   |                             |                   |
| No/yes                                         | 49/38                       | 1/13              |
| Serum amylase level of the next day (IU/mL)     |                             |                   |
| Median                                         | 1001                        | 1543              |
| (range)                                        | (83-3604)                   | (258-2969)        |
| White blood cell of the next day (/μL)          |                             |                   |
| Median                                         | 8040                        | 8790              |
| (range)                                        | (3240-26320)                | (6270-13410)      |
| C-reactive protein of the next day (mg/dL)      |                             |                   |
| Median                                         | 2.08                        | 3.1               |
| (range)                                        | (0.04-32.55)                | (0.20-38.31)      |

ERCP: Endoscopic retrograde cholangiopancreatography; PEP: Post endoscopic retrograde cholangiopancreatography pancreatitis; EST: Endoscopic sphincterotomy; EPBD: Endoscopic papillary balloon dilation; IDUS: Intraductal ultrasonography.
stenting in patients with residual contrast medium in the pancreatic duct at completion of ERCP is expected.

In addition, development of abdominal pain within 3 h after completion of ERCP was a strong risk factor of sPEP. In our facility, cannulation is intended to be followed by 25-50 mg dose of rectal indomethacin only when abdominal pain exceeded restraining pain. Elmunzer et al.[14] reported that rectal indomethacin significantly reduced the incidence of PEP in patients with a PEP risk factor. On the other hand, Levenick et al.[13] reported that the preventive rectal indomethacin does not always inhibit PEP in all ERCP-applied cases. They mentioned that the rectal indomethacin can prevent PEP only in patients with a risk factor of PEP, and its indication should be reconsidered. Moreover, 100 mg of indomethacin is excessive for Japanese with a relatively small physique, and not all ERCP cases are treated with rectal indomethacin at our facility. Furthermore, this treatment inhibited some cases of PEP, but it did not prevent the progression to sPEP in our study. This might have been due to differences in the indication of the rectal indomethacin.

There are several limitations in this study. No diagnosis by exclusion based on the indication and intervention was established. Since it was a retrospective study performed at a single institution, the sample size was small. However, risk factors of sPEP were clarified and these may contribute to demonstrating appropriate conditions and methods to prevent sPEP. As discussed with many PEP-inhibitory methods, the addition of preventive techniques, such as EST and pancreatic duct stenting, and preventive drug administration, such as rectal indomethacin, should be performed after clarifying risk factors of sPEP.

Residual contrast medium in the pancreatic duct at completion of ERCP and development of abdominal pain within 3 h after completion of ERCP are risk factors of sPEP. The presence of these findings is an indication of therapeutic intervention for sPEP, and a method to avoid it should be considered.

### Table 3 Univariate analyses of characterization for severe post-endoscopic retrograde cholangiopancreatography pancreatitis

| Variables                      | No. of patients (n = 121) | Median of patients (range) | Univariate analysis |
|--------------------------------|---------------------------|----------------------------|---------------------|
| Age (yr) (n = 121)             | 76 (18-91)                | 0.874                      |                     |
| Gender (n = 121)               |                           | 0.818                      |                     |
| Male/female                    | 64/57 (54.2)              | 0.379                      |                     |
| Smoking status (n = 121)       |                           | 0.201                      |                     |
| Non-smoker/Ex- or current smoker | 90/31 (74.2)             |                            |                     |
| Drinking status (n = 121)      |                           | 0.302                      |                     |
| Absent/present                 | 79/42 (64.7)              |                            |                     |
| Past history (n = 121)         |                           | 0.967                      |                     |
| Absent/present                 | 35/86 (29.2)              |                            |                     |
| Malignant disease (n = 121)    |                           | 0.550                      |                     |
| Absent/present                 | 94/27 (77.5)              |                            |                     |
| History of pancreatitis (n = 121) | 119/7 (97.5)           | 0.606                      |                     |
| Absent/present                 | 114/7 (94.1)              |                            |                     |
| Diverticulum nearby vater papilla (n = 121) | 325 (27.0) | 0.644                      |                     |
| CBD diameter of patient with CBD stones (n = 41) | 81/40 (20.0) | 0.796                      |                     |

BMI: Body mass index; SOD: Sphincter of Oddi dysfunction; CBD: Common bile duct.

### Table 4 Univariate analyses of clinical data and endoscopic retrograde cholangiopancreatography intervention for post-endoscopic retrograde cholangiopancreatography pancreatitis

| Variables                                      | No. of patients (n = 121) | Median of patients (range) | Univariate analysis |
|-----------------------------------------------|---------------------------|----------------------------|---------------------|
| ERCP procedure                                |                           | 104/17 (86.9)              | 0.429               |
| Not emergency/emergency                        |                           |                            |                     |
| EST                                           |                           | 31 (25.8)                  | 0.650               |
| EPBD                                          |                           | 14 (11.6)                  | 0.736               |
| Pancreatography                               |                           |                            | 0.798               |
| No/yes                                        |                           | 47/74 (39.0)               | 0.011               |
| Contrast media remained in the pancreatic duct |                           |                            |                     |
| No/yes                                        |                           | 80/41 (66.1)               | 0.168               |
| Transpapillary biopsies                        |                           | 95/26 (78.1)               | 0.975               |
| Sphincterotomy                                |                           |                            |                     |
| No/yes                                        |                           | 86/35 (70.7)               |                     |
| Time for ERCP procedure (min)                  |                           | 50 (12-170)                | 0.343               |
| Expertise of ERCP procedure                   |                           |                            | 0.65                |
| Not expert/expert                             |                           | 71/50 (58.7)               |                     |
| Abdominal pain within three hours after ERCP |                           |                            | 0.006               |
| No/yes                                        |                           | 50/51 (41.6)               |                     |
| Serum amylase level of the next day (IU/mL)   |                           | 1065 (83-3604)             | 0.184               |
| White blood cell of the next day (/μL)        |                           | 8050 (3240-26320)          | 0.668               |
| C-reactive protein of the next day (mg/dL)    |                           | 2.1 (0.04-38.31)           | 0.601               |

ERCP: Endoscopic retrograde cholangiopancreatography; EST: Endoscopic Sphincterotomy; EPBD: Endoscopic papillary balloon dilation; IDUS: Intraductal ultrasonography.

### Table 5 Multivariate analyses of risk factors for severe post-Endoscopic retrograde cholangiopancreatography pancreatitis

| Variables                                      | Odds ratio (95%CI)       | P value |
|-----------------------------------------------|--------------------------|---------|
| Contrast media remained in the pancreatic duct| 4.254 (1.238-14.616)     | 0.021   |
| No/yes                                        |                           |         |
| Abdominal pain within three hours after ERCP | 11.881 (1.400-100.784)   | 0.025   |

ERCP: Endoscopic retrograde cholangiopancreatography.
Background
Cholangiopancreatitis pancreatitis (PEP) is an unavoidable endoscopic complication for pancreatobiliary systems. Since PEP is a predictable pathology, and if discovered and appropriately treated early many patients rapidly recover. However, some cases aggravate to a severe state and become fatal. Therefore, it is important to identify factors leading PEP to a severe state.

Research frontiers
There are many reports about risk factors of PEP; however, there are few reports to assess the risk factors of severe PEP (sPEP).

Innovations and breakthrough
Significant differences were noted in residual enhancement of the pancreatic duct and development of abdominal pain showing that these were independent risk factors of sPEP.

Applications
The presence of residual contrast medium in the pancreatic duct at completion of endoscopic retrograde cholangiopancreatography (ERCP) and development of abdominal pain within 3 h after completion of ERCP is an indication of therapeutic intervention for sPEP, and a method to avoid it should be considered.

Terminology
PEP is one of the major adverse events of ERCP. Some PEP aggravate to severe state as sPEP. sPEP sometimes results in the death, so that it has been the most concern still now.

Peer-review
This is a unique single center retrospective study with a significant number of patients investigating an important topic, the risk factors of severe PEP and clarify the indication of prophylactic treatments. The results have a clinical impact on detecting the patients in need for therapeutic intervention for preventing severe PEP, and a method to avoid it should be considered.

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