Efficacy and safety of limited endoscopic sphincterotomy before self-expandable metal stent insertion for malignant biliary obstruction

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AIM
To evaluate the safety and efficacy of limited endoscopic sphincterotomy (ES) before placement of self-expandable metal stent (SEMS).

METHODS
This was a retrospective analysis of 244 consecutive patients with unresectable malignant biliary obstruction, who underwent placement of SEMSs following limited ES from December 2008 to February 2015. The diagnosis of malignant biliary obstruction and assessment of patient eligibility for the study was established by a combination of clinical findings, laboratory investigations, imaging and pathological results. All patients were monitored in the hospital for at least 24 h following endoscopic retrograde cholangiopancreatography (ERCP). The incidence of immediate or early post-ERCP complications such as post-ERCP pancreatitis (PEP) and bleeding related to limited ES were considered as primary outcomes. Also, characteristics and complications according to the cancer type were classified.

RESULTS
Among the 244 patients included, the underlying diagnosis was cholangiocarcinoma in 118 patients,
pancreatic cancer in 79, and non-pancreatic or non-biliary malignancies in the remaining 47 patients. Early post-ERCP complications occurred in 9 patients (3.7%), with PEP in 7 patients (2.9%; mild, 6; moderate, 1) and mild bleeding in 2 patients (0.8%). There was no significant association between the incidence of post-ERCP complications and the type of malignancy (cholangiocarcinoma vs pancreatic cancer vs others, \( P = 0.696 \)) or the type of SEMS used (uncovered vs covered, \( P = 1.000 \)). Patients who had more than one SEMS placed at the first instance were at a significantly higher risk of post-ERCP complications (one SEMS vs two SEMS, \( P = 0.031 \)). No other factors were predictive of post-ERCP complications.

**CONCLUSION**

Limited ES is feasible and safe, and effectively facilitates the placement of SEMS, without any significant risk of PEP or severe bleeding.

**Key words:** Endoscopic sphincterotomy; Endoscopic retrograde cholangiopancreatography; Complications; Pancreatitis; Bleeding; Cholestasis; Self-expandable metal stent

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**Core tip:** The role of routine endoscopic sphincterotomy (ES) is still controversial in biliary stenting and there is a lack of systematic study for the extent of ES and its correlation with the incidence of complications. We retrospectively evaluated the safety and efficacy of limited ES before self-expandable metal stent insertion. We have proved in this study that limited ES doesn’t increase the risk of post-procedure complications such as post-endoscopic retrograde cholangiopancreatography pancreatitis and bleeding. Also, it is advantageous in facilitating the more complex stenting procedures. Therefore, limited ES can be a safe, feasible, and effective therapeutic strategy in the placement of self-expandable metal stent.

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**INTRODUCTION**

Malignant biliary obstruction is mainly caused by cholangiocarcinoma, pancreatic cancer, gallbladder cancer, and metastatic disease. The prognosis is very poor because the lesions are unresectable at diagnosis in the majority of these patients, with less than 20% of the patients being suitable for surgical resection\(^1\).

Endoscopic retrograde cholangiopancreatography (ERCP) along with biliary stenting is a minimally invasive procedure for palliation of biliary obstruction that provides relief from jaundice and improves the quality of life of patients with unresectable malignant biliary obstruction\(^2\).

Self-expandable metal stents (SEMS), compared to plastic stents, have superior patency and are cost-effective options in selected preoperative patients or in patients whose life expectancy exceeds six months\(^3-5\). They are, however, reported to be associated with a higher incidence of pancreatitis\(^6-7\). Previous studies indicate that performing endoscopic sphincterotomy (ES) before stent insertion may lower the incidence of post-ERCP pancreatitis (PEP)\(^8-10\). ES may also facilitate cannulation of the bile duct during difficult ERCPs, reduce resistance to the passage of stents, improve immediate stent deployment, and increase the luminal diameter of the distal common bile duct (CBD)\(^9-12\). Many endoscopists routinely perform ES before SEMS placement. However, the role of routine ES before stenting is still controversial and no clear guidelines exist to govern its use. Additionally, ES is also an independent risk factor for complications such as pancreatitis, bleeding, and perforation, with a reported complication rate of approximately 10% and an overall direct or indirect procedure-related mortality of 0.42%, even when performed by experienced endoscopists\(^2,13-17\). However, an accurate assessment of the incidence of complications based on the extent of ES is difficult to make owing to the lack of such data in previous studies. Herein, we studied the incidence of early post-ERCP complications, such as PEP and bleeding following limited ES accompanying SEMS placement for biliary drainage in patients with malignant biliary obstruction.

**MATERIALS AND METHODS**

**Patients**

This was a retrospective analysis of all patients who underwent endoscopic biliary SEMS placement for the first time for malignant biliary obstruction at the Pusan National University Yangsan Hospital during the six-year period from December 2008 to February 2015. Patients that underwent transpapillary SEMS placement after limited ES for a diagnosis of distal or hilar malignant biliary strictures were included in this study. Diagnosis of the disease and assessment of patient eligibility for the procedure was based on a combination of clinical findings, laboratory investigations and radiological studies including computed tomography (CT) scan, magnetic resonance imaging (MRI) and/or endoscopic ultrasound (EUS). In case of without cholangitis, painless jaundice and/or pruritus, sometimes anorexia, weight loss and malaise were main clinical symptoms. The main laboratory parameters recorded were complete blood count (CBC), total bilirubin, liver function test, calcium, C-reactive protein, sodium, potassium, carbon dioxide, bicarbonate, and alkaline phosphatase.

The simplest way to perform sphincterotomy is a needle-knife, but such a procedure is difficult to make owing to the lack of such data. The role of routine ES before stenting is still controversial and no clear guidelines exist to govern its use. Additionally, ES is also an independent risk factor for complications such as pancreatitis, bleeding, and perforation, with a reported complication rate of approximately 10% and an overall direct or indirect procedure-related mortality of 0.42%, even when performed by experienced endoscopists. However, an accurate assessment of the incidence of complications based on the extent of ES is difficult to make owing to the lack of such data in previous studies. Herein, we studied the incidence of early post-ERCP complications, such as PEP and bleeding following limited ES accompanying SEMS placement for biliary drainage in patients with malignant biliary obstruction.
function tests including alanine aminotransferase, alkaline phosphatase, γ-glutamyltransferase and tumor markers such as CEA and CA 19-9. CT scan was performed for all patients as an initial test, while MRI was performed in all patients with suspicious malignant biliary strictures. MRI was not performed in uncooperative patients or if contraindicated owing to the presence of intracorporeal metallic device or foreign body. EUS was not routinely performed, and was limited to investigating indeterminate biliary strictures, nonvisible masses, or when tissue acquisition was required for definite diagnosis. Pathology results were reviewed in cases where biopsy was performed during ERCP or EUS. Exclusion criteria were previous ES or stent placement, coagulopathy (international normalized ratio > 1.5), low platelet count (< 50000/mL), current use of anticoagulant or antiplatelet drugs, severe cholangitis with or without septic shock, Billroth II anatomy or Roux-en-Y gastrojejunostomy, and severe heart or pulmonary disease. The study protocol was approved by the ethics committee of the Institutional Review Board of Pusan National University Yangsan Hospital (IRB No. 05-2015-081).

Study protocol
Patient characteristics including age, sex, history of previous procedures and baseline biochemical and hematological values were collected prior to performing ERCP. SEMS placement was performed in all patients by one of two experienced endoscopists (endoscopist A had performed > 10000 ERCPs over 20 years; endoscopist B had performed > 2000 ERCPs over 10 years). All patients received intravenous (IV) broad-spectrum antibiotics. Nafamostat mesilate (20 mg) was administered for all patients for preventing post-ERCP pancreatitis. Nonsteroidal anti-inflammatory drugs were not used routinely. All procedures were performed under conscious sedation by using IV midazolam and pethidine, with the patient in the supine or left lateral decubitus position. Cimetropium bromide 10 mg IV was administered to reduce duodenal peristalsis. All ERCPs were performed by using a standard side-viewing duodenoscope (JF-260 V or TJF-240; Olympus Optical Co., Ltd., Tokyo, Japan). Selective cannulation of the bile duct was achieved by using a pull-type double-lumen sphincterotome (Ultratome XL, Boston Scientific, Natick, Mass) or by a conventional ERCP catheter (Fluoro Tip, Boston Scientific), with or without a hydrophilic guidewire (0.025- or 0.035-inch Jagwire, Boston Scientific). A wire-guided cannulation technique was attempted first, followed by the conventional contrast-assisted cannulation technique if biliary cannulation was not achieved within 10 min. After successful guidewire placement, limited sphincterotomy was performed with blended current. Limited ES was defined as ES limited to one-third the extent of major ES. A metal stent was then inserted over the guidewire under fluoroscopic control. Stent length (4 cm to 12 cm) and the need for unilateral or bilateral stent placement were determined based on the location and length of the biliary stricture. Stent placement ensured that the stent spanned the stricture with either end of the stent extending a minimum of 1 cm beyond the stricture. In the case of distal biliary strictures, the distal end of SEMS was placed across the papilla with 1 cm of the distal end of the stent exposed in the duodenum. In the case of hilar biliary strictures, SEMS was placed above the sphincter of Oddi. All patients were monitored in the hospital for at least 24 h after ERCP to identify early post-ERCP complications. CBC, serum amylase, and lipase levels were routinely evaluated at 4 h and 24 h after the procedure. Endoscopy was performed to evaluate ES-related-bleeding on the day following stent placement. All adverse events were recorded. During the follow up period, ERCP was repeated on suspecting stent complications such as occlusion or migration.

Definitions
According to updated Tokyo guidelines (TG13) for diagnosis and severity grading of acute cholangitis, cholangitis was defined as fever and/or shaking chills, increased inflammatory response (abnormal white blood cell counts, increased serum C-reactive protein levels) and jaundice (total bilirubin ≥ 2 mg/dL) or abnormal liver function tests (> 1.5 × upper limit of normal value) [18]. Severe cholangitis is defined as the presence of accompanying organ dysfunction caused by biliary sepsis, and requiring intensive care such as respiratory and circulatory support [8]. Limited ES was defined as sphincterotomy less than one-third the extent of major ES [19]. Definitions of individual post-procedure complications were according to the descriptions given by Cotton et al. [20]. PEP was defined as new-onset or worsening abdominal pain lasting more than 24 h after the procedure, in conjunction with pancreatic enzyme (amylase and/or lipase) elevation that was at least three times the upper limit of the normal, with or without radiographic evidence of acute pancreatitis. The severity of PEP was graded by using the number of hospitalization days: mild, when hospitalization was prolonged by 2 to 3 d, moderate, by 4 to 10 d, and severe, by more than 10 d [20]. Bleeding was defined as the presence of melena or hematemesis, irrespective of the need for blood transfusion or repeat endoscopy. Mild bleeding was defined as hemoglobin drop within 2 g/dL, with no necessity for blood transfusion. The presence of bleeding was identified based on patient’s history (melena or hematemesis) and a drop in hemoglobin level following the procedure. Perforation was considered as perforation of retroperitoneum or bowel walls documented by any of the radiographic techniques [21]. Complications were graded according to the grading system described by Cotton et al. [20]. Early complications or adverse events were defined as any ERCP-related complications occurring within 30 d
of the procedure. Patency interval was defined as the period between the first SEMS deployment and the occurrence of stent complications such as occlusion or migration.

**Statistical analysis**

The primary outcomes measured were immediate or early complications within 30 d of the procedure. For inter-group differences, Student’s t-test was performed for continuous variables, and $\chi^2$ test or Fisher’s exact test were performed for categorical variables. Results were considered statistically significant at a $P$ value < 0.05. Data were analyzed by using SPSS software version 18.0 (SPSS, Chicago, IL, United States).

**RESULTS**

A total of 244 patients that underwent limited ES and biliary stenting for malignant biliary obstruction between December 2008 and February 2015 were included in the study. The etiology of malignant biliary obstruction included cholangiocarcinoma ($n = 118$, 48.4%), pancreatic cancer ($n = 79$, 32.4%), and others including gallbladder cancer ($n = 21$, 8.6%), ampullary cancer ($n = 18$, 7.4%), and hepatocellular carcinoma and metastatic cancer ($n = 8$, 3.2%). Mean age was $70.8 \pm 10.2$ (range, 44-95) years and 130 (53.3%) were males and 114 (46.7%) were females. Stents were successfully deployed in all patients. Early post-ERCP complications occurred in 9 patients (3.7%), including PEP in 7 patients (2.9%; mild, 6; moderate, 1), and mild bleeding in 2 patients (0.8%). All patient with post-ERCP complications responded to conservative management. Stent occlusion and migration developed in 44 patients (18.0%) and 1 patient (0.4%), respectively. Patients with late complications underwent repeat ERCP or percutaneous transhepatic biliary drainage. Patient characteristics and ERCP related data are summarized in Table 1.

On categorizing patients into three groups on the basis of cancer location, PEP developed in 4 patients (3.4%, 4/118) with cholangiocarcinoma, 1 patient (1.3%, 1/79) with pancreatic cancer, and 2 patients (4.3%, 2/47) with non-pancreatic, non-biliary cancers ($P = 0.681$). There were no significant differences among these three groups as to the incidence of immediate or early complications ($P = 0.696$) (Table 2). In the cholangiocarcinoma group, the incidence of PEP was 4.0% and 2.3% with hilar and distal cholangiocarcinoma, respectively ($P = 0.537$). One patient with hilar cholangiocarcinoma had mild bleeding (Table 3). In the pancreatic cancer group, one patient had PEP and another had mild bleeding. Both complications developed in patients with pancreatic head cancer and none were reported in cases of pancreatic body and/or tail cancer (Table 4).

| Characteristics | Value |
|-----------------|-------|
| Age (yr), mean ± SD (range) | $70.8 \pm 10.2$ (44-95) |
| Sex | |
| Male | 130 (53.3) |
| Female | 114 (46.7) |
| Aspirin | 3 (1.2) |
| Total bilirubin (mg/dL), pre-procedure, mean ± SD (range) | $7.09 \pm 6.45$ (0.2-28.9) |
| Normal | 53 (21.7) |
| Elevated | 191 (78.3) |
| Hyperamylasemia, pre-procedure | 14 (5.7) |
| Cholangitis, pre-procedure | 68 (27.9) |
| Diagnosis | |
| Cholangiocarcinoma | 118 (48.4) |
| Hilar | 75 (63.6) |
| Distal | 43 (36.4) |
| Pancreatic cancer | 79 (32.4) |
| Head | 68 (86.1) |
| Body/Tail | 11 (13.9) |
| Gallbladder cancer | 21 (8.6) |
| Ampullary cancer | 18 (7.4) |
| Hepatocellular carcinoma | 3 (1.2) |
| Others | 5 (2.0) |
| Pancreatic duct invasion | |
| Yes | 85 (34.8) |
| No | 159 (65.2) |
| Lymph node metastasis | |
| Yes | 170 (69.7) |
| No | 73 (29.9) |
| Pancreatic duct injection | |
| 0 | 187 (76.6) |
| 1-2 | 24 (9.8) |
| $\geq 3$ | 33 (13.5) |
| ERPD | 4 (1.6) |
| Stent success rate | 244 (100) |
| Number of initially inserted SEMS | |
| 1 | 230 (94.3) |
| 2 | 14 (5.7) |
| Stent type | |
| Uncovered | 190 (77.9) |
| Covered | 54 (22.1) |
| Post-ERCP complication | |
| Present | 9 (3.7) |
| Absent* | 234 (95.9) |
| Post-ERCP complication type | |
| Pancreatitis | 7 (2.9) |
| Mild / moderate | 6 (2.5)/1 (0.4) |
| Bleeding, mild | 2 (0.8) |
| Perforation | 0 (0) |
| Post-ERCP hyperamylasemia | 30 (12.3) |
| Stent complication | |
| None | 199 (81.6) |
| Stent occlusion | 44 (18.0) |
| Stent migration | 1 (0.4) |
| Patency | |
| No further procedure | 199 (81.6) |
| ERBD restent | 1 (0.4) |
| SEMS restent | 32 (13.1) |
| PTBD | 12 (4.9) |

*SEMS: Self-expandable metal stent; ERPD: Endoscopic retrograde pancreatic drainage; ERBD: Endoscopic retrograde biliary drainage; PTBD: Percutaneous transhepatic biliary drainage.

Table 1  Patient characteristics and endoscopic retrograde cholangio pancreatography related data n (%) (n = 244)
On categorizing patients based on the type of SEMS deployed, 190 patients (78%) had uncovered SEMS while 54 patients (22%) had covered SEMS. Rates of PEP with uncovered and covered SEMS were 2.6% (5/190; mild, 4; moderate, 1) and 3.7% (2/54, both mild), respectively \((P = 0.652)\). Mild bleeding occurred in 2 patients (1.1%) in the uncovered SEMS group alone. No significant differences were found between these two groups as to the incidence of post-ERCP complications \((P = 1.000)\) (Table 5).

On comparing patients with no complications \((n = 235)\) and those with complications \((n = 9)\), the only
factor that was significantly different between the two groups was the number of SEMS initially deployed [one SEMS vs two SEMS (bilateral), \(P = 0.031\)] (Table 6). Of the 231 patients with one SEMS, 5 patients developed PEP and 2 patients developed mild bleeding, while of the 13 patients with two SEMS, 2 patients developed PEP.

### DISCUSSION

ES is an established technique and is commonly used to facilitate biliary stone removal. In contrast, the role of routine ES prior to stent insertion is still controversial. Many endoscopists prefer to perform ES before stenting to reduce the risk of PEP, achieve better biliary drainage, and facilitate stent placement. However, sphincterotomy carries risks such as bleeding, perforation and pancreatitis\(^{[9]}\). Some studies have reported that the risks of ES might exceed any benefits owing to a high incidence of ES-related complications\(^{[15]}\). Cotton et al.\(^{[20]}\) reported bleeding and pancreatitis as major early complications with ES. Freeman et al.\(^{[15]}\) evaluated early complications following ES and reported their incidence as 9.8% (pancreatitis, 5.4%; bleeding, 2.0%).

Previous studies, however, lack details regarding the extent of ES and its correlation with the incidence of complications. In this study, we performed limited ES before SEMS placement and described the safety of limited ES by evaluating early post-ERCP complications in patients with malignant biliary obstruction. The overall rate of early post-ERCP complications after SEMS placement with limited ES was 3.7%, including a 2.9% incidence of PEP, and 0.8% of mild bleeding. These

### Table 4 Rates of complications on biliary stenting with limited endoscopic sphincterotomy according to location of pancreatic cancer \(n (\%)\)

| Post-ERCP complication type | Head \(n = 68\) | Body / Tail \(n = 11\) | \(P\) value |
|-----------------------------|-----------------|-------------------------|-----------|
| Pancreatitis                 | 1 (1.5)         | 0 (0.0)                 | 1.000     |
| Mild/moderate                | 1 (1.5)         | 0 (0.0)                 |           |
| Bleeding, mild               | 1 (1.5)         | 0 (0.0)                 |           |
| Perforation                  | 1 (1.5)         | 0 (0.0)                 |           |
| Post-ERCP hyperamylasemia    | 8 (11.8)        | 2 (18.2)                | 0.624     |
| Stent complication           |                 |                         | 1.000     |
| None                         | 60 (88.2)       | 10 (90.9)               |           |
| Stent occlusion              | 8 (11.8)        | 1 (9.1)                 |           |
| Stent migration              | 0 (0.0)         | 0 (0.0)                 |           |

ERCP: Endoscopic retrograde cholangio pancreatography.

### Table 5 Rates of complications on biliary stenting with limited endoscopic sphincterotomy according to stent type \(n (\%)\)

| Post-ERCP complication type | Uncovered \(n = 190\) | Covered \(n = 54\) | \(P\) value |
|-----------------------------|----------------------|-------------------|-----------|
| Normal                      | 181 (95.3)           | 49 (90.7)         |           |
| Abnormal                    | 9 (4.7)              | 5 (9.3)           |           |
| Post-ERCP complication      |                      |                   | 1.000     |
| Present                     | 7 (3.7)              | 2 (3.7)           |           |
| Absent                      | 183 (96.3)           | 52 (96.3)         |           |
| Post-ERCP complication type |                      |                   | 0.838     |
| Pancreatitis                | 5 (2.6)              | 2 (3.7)           |           |
| Mild / moderate             | 4 (2.1) / 1 (0.5)    | 2 (3.7) / 0 (0.0) |           |
| Bleeding, mild              | 2 (1.1)              | 0 (0)             |           |
| Perforation                 | 0 (0)                | 0 (0)             |           |
| Post-ERCP hyperamylasemia   | 25 (13.2)            | 5 (9.3)           | 0.638     |
| Stent complication          |                      |                   | 0.758     |
| None                        | 156 (82.1)           | 43 (79.6)         |           |
| Stent occlusion             | 33 (17.4)            | 11 (20.4)         |           |
| Stent migration             | 1 (0.5)              | 0 (0)             |           |
| Patency                     |                      |                   | 0.012     |
| No further procedure        | 156 (82.1)           | 43 (79.6)         |           |
| ERBD restent                | 1 (0.5)              | 0 (0)             |           |
| SEMS restent                | 28 (14.7)            | 4 (7.4)           |           |
| PTBD                         | 5 (2.6)              | 7 (13)            |           |

SEMS: Self-expandable metal stent; ERBD: Endoscopic retrograde biliary drainage; PTBD: Percutaneous transhepatic biliary drainage; ERCP: Endoscopic retrograde cholangio pancreatography.
rates of complications are relatively low compared to the complication rates of approximately 10% and an overall mortality of 0.42% in published data[2,13-17].

Bleeding is a serious complication of ES and its incidence is reported to be between 1 and 10%[12,22-25]. In our study, only 2 patients (0.8%) developed mild bleeding, which could be managed by conservative treatment. No instances of moderate or severe bleeding were reported. Wang et al[26], in their analysis of delayed hemorrhage following ES in 1741 patients did not find delayed bleeding in any patient who underwent small ES (n = 194). These results might be related to the limited extent of the ES and the compressive effect of the SEMS[27]. On the basis of these studies, limited ES does not seem to be associated with clinically significant bleeding.

A recent meta-analysis by Cui et al[28], analyzing biliary stenting for malignant biliary obstruction reported that the incidence of PEP was significantly lower with ES than without ES (3.5% vs 8.9%, P = 0.04, OR = 0.34, 95%CI: 0.12-0.93) and recommended ES before stent placement as a useful option to reduce the incidence of PEP. Similar low rates (2.2%) were reported by Giorgio et al[29] in their randomized control trial involving 10 Fr plastic stent after ES for inoperable malignant common bile duct (CBD) obstruction. In our study, despite the absence of a control group, the low rate of PEP (2.9%) is comparable to the results of the

| Table 6 Characteristics according to complications on biliary stenting with limited endoscopic sphincterotomy a (%) |
|-----------------------------------------------|
| **No complication** a = 235                  | **Complication** a = 9                     | **P value** |
| **Age (yr), mean ± SD (range)**              |                                              |            |
| 70.61 ± 10.33                                | 75.27 ± 5.55                                | 0.993      |
| **Gender**                                   |                                              | 1.000      |
| **Male**                                     | 126 (53.6)                                  |            |
| **Female**                                   | 109 (46.6)                                  |            |
| **Total bilirubin (mg/dL), pre-procedure, mean ± SD** | 7.00 ± 6.46                                | 0.362      |
| **Normal**                                   | 52 (22.2)                                   | 0.433      |
| **Elevated**                                 | 183 (77.8)                                  |            |
| **Hyperamylasemia, pre-procedure**          | 8 (88.9)                                    |            |
| **Cholangitis, pre-procedure**               | 3 (3.3)                                     | 0.485      |
| **Diagnosis**                                | 64 (27.2)                                   | 0.472      |
| **Cholangiocarcinoma**                       | 112 (47.6)                                  | 0.748      |
| **Hilar**                                    | 71 (30.2)                                   |            |
| **Distal**                                   | 41 (17.4)                                   |            |
| **Pancreatic cancer**                        | 77 (32.8)                                   |            |
| **Head**                                     | 66 (28.1)                                   |            |
| **Body / tail**                              | 11 (4.7)                                    |            |
| **Gallbladder cancer**                       | 20 (8.5)                                    |            |
| **Ampullary cancer**                         | 18 (7.7)                                    |            |
| **Hepatocellular carcinoma**                 | 3 (1.3)                                     |            |
| **Others**                                   | 5 (2.1)                                     |            |
| **Pancratic duct invasion**                  |                                              | 0.324      |
| **Yes**                                      | 80 (34.0)                                   |            |
| **No**                                       | 155 (66.0)                                  |            |
| **Lymph node metastasis**                    |                                              | 0.176      |
| **Yes**                                      | 166 (70.6)                                  |            |
| **No**                                       | 69 (29.4)                                   |            |
| **Pancreatic duct injection**                |                                              | 0.662      |
| **0**                                        | 181 (77.0)                                  |            |
| **1-2**                                      | 23 (9.8)                                    |            |
| **≥ 3**                                      | 31 (13.2)                                   |            |
| **Number of inserted SEMS**                  |                                              | 0.031      |
| **1**                                        | 224 (95.3)                                  |            |
| **2**                                        | 11 (4.7)                                    |            |
| **Stent type**                               |                                              | 1.000      |
| **Uncovered**                                | 183 (77.9)                                  |            |
| **Covered**                                  | 52 (22.1)                                   |            |
| **Stent complication**                       |                                              | 1.000      |
| **Stent occlusion**                          | 42 (17.9)                                   |            |
| **Stent migration**                          | 1 (0.4)                                     |            |
| **Patency**                                  |                                              | 0.512      |
| **No further procedure**                     |                                              |            |
| **ERBD restent**                             | 192 (81.7)                                  |            |
| **SEMS restent**                             | 31 (13.2)                                   |            |
| **PTBD**                                     | 11 (4.7)                                    |            |

SEMS: Self-expandable metal stent; ERBD: Endoscopic retrograde biliary drainage; PTBD: Percutaneous transhepatic biliary drainage; ERCP: Endoscopic retrograde cholangio pancreatography.
two above-mentioned studies. Our PEP rates are also low compared to the rates of 9.4% and 6.3%, with metal stent placement following ES for distal biliary strictures, reported by Hayashi et al\textsuperscript{[17]} and by Kahaleh et al\textsuperscript{[20]}. In our study, the incidence of PEP was 4.0% in hilar cholangiocarcinoma and 2.3% in distal cholangiocarcinoma. Although the outcomes with ES for malignant biliary strictures, especially cholangiocarcinoma, are controversial, several previous studies have demonstrated a lower incidence of PEP in the ES group compared to the non-ES group\textsuperscript{[8,9,31]}. Jeong et al\textsuperscript{[6,8]} investigated the risk of pancreatitis in patients with malignant obstructive jaundice following percutaneous or transpapillary stent placement. They also studied the effect of preliminary ES in the transpapillary stent group. Their results demonstrated a higher rate of pancreatitis in the transpapillary stent group ($P = 0.502$) and the authors concluded that SEMS placement through the intact sphincter of Oddi may increase the risk of pancreatitis.

The management of hilar obstruction is more difficult than distal bile duct strictures because of the underlying anatomical and technical complexity. Bilateral stent placements for Bismuth type II to IV hilar cholangiocarcinoma are also very complicated and result in increased endoscopic manipulations\textsuperscript{[32]}. The higher incidence of post-ERCP complications in patients who had two SEMS (bilateral stents) placed could be related to these reasons. In these situations, limited ES before stenting could be an effective strategy for facilitating more complex stenting procedures\textsuperscript{[33]}. Limited ES may allow for easier stent placement and reduce resistance to biliary instrumentation. Additionally, proximal bile duct strictures may contribute to a fulcrum effect resulting in medial displacement of the distal stent and, consequently, stent related compression of the pancreatic duct\textsuperscript{[39]}. Limited ES might prevent the risk of pancreatitis by reducing stent-related pancreatic duct obstruction. In case of distal CBD strictures, ES may allow the stent to achieve a better final diameter, and thus, better drainage.

Our data demonstrated a lower rate of PEP in patients with cholangiocarcinoma compared to previous studies. Limited ES, therefore, could be an effective and useful technique to prevent PEP following stenting for cholangiocarcinoma, especially hilar tumors. The incidence of PEP was lesser in pancreatic cancers than in cholangiocarcinoma in this study (1.3% vs 3.4%, $P = 0.681$). Some studies demonstrated that pancreatic cancers with obstruction of the main pancreatic duct had a lower degree of PEP, possibly due to diminished pancreatic exocrine function and suggested that ES may be unnecessary in such cases\textsuperscript{[12,17,28,32]}. Although further confirmation is required, we noted that performing limited ES prior to SEMS placement in patients with unresectable pancreatic cancers did not result in a higher incidence of adverse events compared to published data\textsuperscript{[17]}. Additionally, it is possible that ES may be advantageous in selected cases, depending on pancreatic duct status, stent diameter, stent type (especially fully covered SEMS) or ampulla size, in rendering the procedure easier as biliary strictures secondary to pancreatic cancer tend to be narrow and rigid. ES may also facilitate stent exchange during the follow-up period\textsuperscript{[32]} as demonstrated in our study, where the success rate of SEM restenting, when indicated, was 97%.

Stent migration is a late complications of biliary stenting with ES. Stent migration seems to be associated with stent type as well as ES. Covered SEMS are not fully embedded in bile duct, and therefore, are associated with the potential risk of stent migration. A previous study reported increased frequency of stent migration when ES was performed before placement of covered SEMS\textsuperscript{[15]}. In contrast, other studies did not support this finding\textsuperscript{[20,24]}. In our study, stent migration occurred in only 1 patient (0.4%) and limited ES did not seem to be a significant factor associated with migration, regardless of the stent type.

This retrospective study has a few limitations. First, the possibility of inaccurate data collection cannot be overlooked. For example, procedure-related abdominal pain is difficult to distinguish from the breakthrough pain of malignancy and may have contributed to bias in measuring the rate of PEP. Second, this study had a single-center design without a control group (non-ES group), which might influence the interpretation of the effect of limited ES. Further prospective multicenter studies with the inclusion of control groups are needed to overcome these limitations.

In conclusion, limited ES is a feasible, safe and effective procedure to facilitate placement of SEMS in patients with malignant bile duct obstruction. Limited ES is not significantly associated with complications like severe bleeding or PEP and its use may represent a better strategy to achieve successful stent placement, especially in cases like hilar strictures that require complex procedural techniques.
bleeding or PEP. It may be useful to achieve successful stent placement. Limited ES is a feasible, safe and effective procedure to facilitate placement of SEMS in patients with malignant biliary obstruction.

**Applications**

This retrospective study showed that limited ES could be useful to facilitate placement of SEMS, especially in cases, like hilar strictures, requiring complex procedural techniques without major complications. Further large randomized controlled trials are required.

**Terminology**

ES is a method to provide access to the biliary system for therapy, which means cutting of the sphincter or muscle that lies at the juncture of the intestine with both the bile and pancreatic ducts. Limited ES is defined as sphincterotomy less than one-third the extent of major ES.

**Peer-review**

This is an interesting manuscript that has not been published extensively. The authors showed in this study that the clinical outcomes in patients who did undergo limited ES before placement of SEMS for malignant biliary obstruction. The results provide new evidence that limited ES could be a feasible strategy for SEMS placement without significant complications.

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