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ORIGINAL ARTICLE - BILIARY AND PANCREATIC

Long-term clinical outcomes of a fully covered self-expandable metal stent for refractory pancreatic strictures in symptomatic chronic pancreatitis: An 11-year follow-up study

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Abstract

Background and Aims: A fully covered self-expandable metal stent (FCSEMS) has recently been applied in the management of chronic pancreatitis patients with pancreatic strictures. However, related long-term effects remain unclear. This study aimed to evaluate the long-term outcomes of FCSEMS placement in chronic pancreatitis patients with refractory strictures.
Method: We retrospectively reviewed our database for patients undergoing FCSEMS placement for refractory pancreatic strictures between September 2008 and December 2010. The main outcomes were technical, radiological, and clinical success, as well as recurrence and adverse events.
Results: A total of 35 patients were included. Technical success was achieved in all patients. The median FCSEMS indwelling time was 3.2 months (interquartile range [IQR], 3.0–4.9 months). Radiological success was achieved in all patients (complete, $n = 2$; partial, $n = 33$). Clinical success was achieved in 29 patients (82.9%; complete analgesic cessation, $n = 19$; analgesic reduction $>50\%$, $n = 11$). During the median follow-up of 136 months, (IQR, 85.8–145.5 months), eight patients (22.9%) experienced recurrence. The median interval from stent removal to recurrence was 24.9 months (IQR, 11.3–30.3 months). Biliary obstruction, an early adverse event, occurred in two patients (5.7%); the late adverse event stent-induced de novo stricture was observed in 17 patients (48.6%).
Conclusions: Our findings suggest that an FCSEMS is effective for relieving refractory strictures in chronic pancreatitis. However, FCSEMSs were associated with stent-induced de novo strictures in nearly half of the patients. Prospective studies are required to further evaluate the long-term efficacy and safety of FCSEMSs in chronic pancreatitis.

Introduction

Endoscopic placement of single plastic stents has been recommended for the management of symptomatic chronic pancreatitis with main pancreatic duct (MPD) stricture.[1] However, this procedure is ineffective in some patients owing to refractory pancreatic strictures.[2] The same reason renders the complete removal of stents difficult in approximately one-third of patients.[3–5] In a recent randomized controlled trial, early surgery yielded better pain relief compared with endoscopic treatment.[6] Nevertheless, pancreatic surgery is associated with a high morbidity of up to 15–30%.[7,8]

Current guidelines recommend the application of multiple side-by-side plastic stents in the management of refractory pancreatic strictures.[1] Fully covered self-expandable metal stent (FCSEMS) placement has been utilized as an alternative treatment option for symptomatic refractory pancreatic strictures in patients with chronic pancreatitis. Albeit several studies have focused on the clinical efficacy and safety of FCSEMS in such patients,[9–13] this has not been sufficiently examined in the long term. Therefore, we aimed to evaluate the long-term clinical outcomes of FCSEMS placement for refractory symptomatic strictures in patients with chronic pancreatitis.

Patients and methods

Patients. We reviewed our database for patients who underwent FCSEMS placement for symptomatic chronic pancreatitis with refractory strictures between January 2008 and December 2010 for the evaluation of long-term clinical outcomes. Our study cohort partly overlaps with those of previously reported cases.[14] The inclusion criteria were as follows: (i) age >18 years; (ii) presence of symptomatic chronic pancreatitis with a focal dominant MPD stricture; (iii) improvement of symptoms after previous plastic stent placement; and (iv) recurrence of pain after initial stricture resolution or persistent stricture despite plastic stenting.[14] Exclusion criteria were as follows: (i) age <18 years; (ii) presence of multifocal MPD strictures; and (iii) location of MPD stricture in the tail of the pancreas. The etiologies of chronic pancreatitis were classified through the medical record review as either alcohol, hereditary, or idiopathic. Hereditary chronic pancreatitis was defined by the detection of mutations in the *PRSS1*, *CFTR*, and *SPINK1* genes.[15] Written informed consent was obtained from all patients before the procedure. The Institutional Review Board of Asan Medical Center approved this study (2022-0004, approval date 03-Jan-2022).

FCSEMS with antimigration features. We used FCSEMSs developed to prevent migration (Niti-S Pancreatic Stent, bumpy type; Taewoong Medical, Seoul, Korea). These stents with a weaving construction have flared ends to reduce migration and are covered with a silicone membrane; and their middle portion, covered with a polytetrafluoroethylene membrane for high conformability, has irregular cell sizes (therefore termed "bumpy"), resulting in different segmental radial forces to reduce migration (Fig.1).[14] The stent introducer size was 8.5 Fr. Dependent on each individual case, FCSEMSs of different diameters (6, 8, or 10 mm) and lengths (4–8 cm) were used. The diameter was selected to match that of a maximally dilated MPD. The length of the stent that was determined also covered at least 1–2 cm beyond the distal part of the stricture site.

Procedures. All procedures were performed according to standardized protocols by expert endoscopists (M.H. Kim [who retired 2 years ago] and S.K. Lee) using a duodenoscope (TJF-260V; Olympus Medical, Tokyo, Japan). If obstructive pancreatic stones smaller than 5 mm were present, they were extracted by endoscopic therapy prior to stent placement. If the pancreaticoliths were larger than 5 mm or could not be removed during the index procedure, stone fragmentation via extracorporeal shock-wave lithotripsy (ESWL) was performed. The number of shockwaves and ESWL sessions applied in these cases were determined by the size and the number of the stones.[1]

Moderate sedation was induced using a combination of midazolam and meperidine or propofol. Pancreatography via papilla cannulation was used to determine the location and length of the dominant stricture. Pancreatic strictures were dilated with an 8.5-Fr biliary dilatation catheter (Soehendra Biliary Dilatation Catheter; Cook Medical, Winston-Salem, NC, USA) or a balloon dilatation catheter (Hurricane; Boston Scientific Corp., Natick, MA, USA) if needed. All FCSEMSs were placed following the transpapillary method, in which the distal end of the stent was exposed to the duodenal lumen. Diameter and length of the stent were chosen by the attending endoscopist. FCSEMSs were removed after a minimum period of 3 months using rat-tooth forceps. After removing the stent, a balloon-occluded pancreaticogram was obtained to evaluate improvements in the stricture and the presence of stent-induced de novo strictures.

Outcome definitions. A refractory stricture was defined as symptomatic MPD stricture that persisted or relapsed within 6 months after 1 year of single pancreatic stent placement.[16,17] The primary outcome was recurrence of MPD stricture, which was defined as pain aggravation requiring hospitalization and related to the recurrence of the original stricture. The secondary outcome measures included technical success, complete or incomplete radiologic success, clinical success, stent migration rate, stent-induced de novo strictures, and development of endocrine insufficiency. Technical success was defined as appropriate

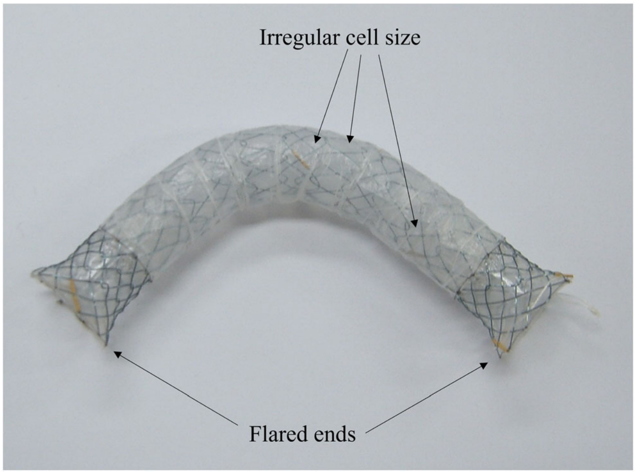

Figure 1 A modified fully covered self-expandable metal stent. The Taewoong Niti-S fully covered self-expandable pancreatic metal stent (bumpy type) used in this study.

placement of an FCSEMS across the stricture. Complete radiologic success was reached if a complete runoff of contrast material could be observed and an inflated extraction balloon could be passed through the pancreatic duct.[14,17] If an FCSEMS was partially expanded and its waist was still visible via fluoroscopy prior to its removal, the case was considered an incomplete radiologic success. Clinical success was defined as a reduction in the dose of analgesics by >50% that persisted for at least 3 months after stent removal.[18] Stent migration was defined as dislocation of the whole FCSEMSs upstream or downstream to stricture site. Stent-induced de novo strictures were defined as newly developed MPD stricture just above the intraductal end of the FCSEMS.[11] Endocrine insufficiency was defined by the development of prediabetes or new-onset diabetes mellitus (NODM) according to guideline of the American Diabetes Association.[19] Procedural adverse events and their severity were classified according to the lexicon for endoscopic adverse events based on consensus guidelines.[20]

Statistical analysis. Descriptive statistics were used to analyze baseline characteristics. Values are presented as medians, interquartile ranges (IQR), and percentages. Categorical parameters are expressed as frequencies and proportions and were compared using the chi-square test or Fisher's exact test. Univariable and multivariable analyses were performed to identify risk factors associated with the development of stent-induced de novo strictures. Factors with a P-value of less than 0.2 in the univariable analysis were eligible for multivariate analysis. The Kaplan–Meier method was used to estimate the recurrence-free interval and overall survival after stent removal. The data were analyzed using R program version 4.1.2 (http://www.R-project.org; R Foundation for Statistical Computing, Vienna, Austria).

Table 1 Baseline characteristics

Variables	n = 35
Age, median, years (IQR)	47 (35–54)
Male sex, n (%)	29 (82.9)
Diabetes, n (%)	16 (45.7)
Divisum, n (%)	4 (11.5)
Etiology, n (%)	
Alcohol	22 (62.9)
Hereditary	7 (20)
Idiopathic	6 (17.1)
Previous plastic stenting, n (%)	35 (100)
Stricture location, n (%)	
Head	31 (88.6)
Neck	4 (11.4)
Presence of pancreaticolith, n (%)	31 (88.6)
Size of pancreaticolith, median, mm (range)	5.5 (2.5–15)
Stent diameter, n (%)	
6 mm	12 (34.3)
8 mm	20 (57.1)
10 mm	3 (8.6)
Stent length, n (%)	
4 cm	2 (5.7)
5 cm	13 (37.1)
6 cm	8 (22.9)
7 cm	8 (22.9)
8 cm	4 (11.4)

FCSEMS, fully covered self-expandable metal stent; IQR, interquartile range.

Results

Patient characteristics. Baseline characteristics are shown in Table 1. A total of 35 patients (29 men; median age, 47 years; range 18–73 years) underwent FCSEMS placement for symptomatic chronic pancreatitis with refractory strictures. The sites of strictures were head (n = 31, 88.6%) and neck (n = 4, 11.4%). Most patients (n = 31, 88.6%) had pancreaticolith. The median size of pancreaticolith was 5.5 mm (range 2.5–15 mm).

Short-term clinical outcomes. Clinical outcomes are summarized in Table 2. Fourteen (45.2%) patients underwent pancreaticolith removal before FCSEMS placement, and ESWL was required in 10 (28.6%) patients, and median session of ESWL was 4 (range 2–9). FCSEMSs were successfully placed through the major papilla in 31 patients (88.6%) and through the minor papilla in four patients (11.4%) with pancreas divisum (technical success, 100%; 95% confidence interval [CI], 87.9–100%). Clinical success was achieved in 29 of 35 patients (82.9%; 95% CI, 65.7–92.8%); among them, 18 patients (51.4%) were able to stop treatment with analgesics, and 11 (31.4%) experienced ≥50% decreases in analgesic doses after FCSEMS insertion. Six patients who did not demonstrate clinical success were managed as follows: replacement of plastic stent in three, surgery in two, and endoscopic ultrasound-guided pancreatic duct drainage (EUS-PD) in one. Radiological success was achieved in all patients (100%; 95% CI, 87.9–100%), with complete radiological

Table 2 Clinical outcomes

Characteristic	Value, n (%)
Technical success, n (%)	35 (100)
Clinical success, n (%)	29 (82.9)
Analgesic cessation	18 (51.4)
Analgesic reduction ≥50%	11 (31.4)
Dwelling duration, months (IQR)	3.2 (3.0–4.9)
Radiologic success, n (%)	
Complete resolution	2 (5.7)
Partial resolution	33 (94.3)
ESWL, n (%)	10 (32.2)[†]
Complete stone removal during follow-up, n (%)	14 (45.1)[†]
Early adverse events, n (%)	
Cholangitis	2 (5.7)
Late adverse events, n (%)	
Stent-induced de novo stricture	17 (48.6)
Symptomatic	8 (22.9)
Recurrence, n (%)	8 (22.9)
Interval from stent removal to recurrence, months (IQR)	24.9 (11.3–30.3)
Follow-up period, months (IQR)	136 (85.8–145.5)

ESWL, extracorporeal shock wave lithotripsy; IQR, interquartile range.
[†]The denominator was set was the number of patients with pancreaticolith.

success in two (5.7%) and partial radiological success in 33 (94.3%). The median indwelling time of placed FCSEMSs was 3.2 months (IQR, 3–4.9 months). During FCSEMS placement, stent migration was not observed in any patient. All FCSEMSs were removed successfully by gentle pulling with rat-tooth forceps.

No stent-related adverse events, such as pancreatic sepsis or stent-induced pancreatitis, were observed after placement. Early adverse events occurred in two patients (5.7%): In both cases, acute cholangitis developed after FCSEMS placement due to stent--induced bile duct orifice obstruction. Endoscopic biliary plastic stent placement led to complete recovery of both patients.

Long-term clinical outcomes. The median follow-up period was 136 months (IQR, 85.8–145.5 months). During follow-up, eight patients (22.9%) experienced recurrence, with a median recurrence-free interval of 24.9 months (IQR, 11.3–30.3 months) (Fig. 2). There was no difference in clinical parameters between recurrence-free and recurrence group except for age (Table S1). Among these, five patients (14.3%) were managed successfully by transpapillary plastic stent placement. The median indwelling time for plastic stent replacement was 2.1 months (range 2.0–3.4 months). In the remaining three patients (8.6%), in whom pain relief was not achieved, surgery (Puestow operation for two patients and pylorus-preserving pancreaticoduodenectomy for one) was performed.

In 27 patients without recurrence, stent-induced de novo strictures were observed in 17 cases (48.6%) (Fig. 3). This late adverse event was diagnosed incidentally in nine patients (25.7%) at the time of planned FCSEMS removal, whereas eight cases (22.9%) showed recurrent pancreatitis after stent removal. Placements of a plastic stent with longer lengths after balloon dilatation and FCSEMS were performed in 11 and one patient, respectively, whereas four patients were followed up without intervention. The median indwelling time for the stents used to treat a de novo stricture was 2.3 months (range 1.4–7.1 months). The remaining patient was treated with EUS-PD, as a guidewire could not be passed through the stricture in this individual. A flowchart of the treatments and follow-up strategies used in our current patient series is shown in Fig. 4. Univariable analysis was performed to search for relevant factors associated with stent-induced de novo strictures. Only the stent diameter (10 mm over 6 mm) was found to be a significant factor in this regard (hazard ratio 1.95; 95% CI, 1.05–3.61). As this one factor was the only variable with a P-value less than 0.02, further multivariable analysis was not possible. The results of the univariable analysis are summarized in Table S2. Among 31 patients who had pancreaticolith, 14 (45.1%) patients achieved complete stone removal at the end of follow-up. In this study cohort, 19 patients were free of prediabetes or diabetes mellitus. During follow-up, eight patients (42.1%) developed NODM. The 10-year overall survival rate was 84.4% (95% CI, 73.0–98.1%). A total of five patients died due to underlying comorbidities (cardiopulmonary disease in four patients and advanced malignancy in one patient).

Discussion

The optimal treatment strategy for chronic pancreatitis with stricture is still under debate. Current guidelines recommend the placement of multiple side-by-side plastic stents for the treatment of refractory pancreatic strictures in patients with chronic pancreatitis.[1] However, this method is technically challenging and requires multiple interventions. As an alternative, FCSEMS placement has been reported for the management of chronic pancreatitis.[9,11,14,17,21]

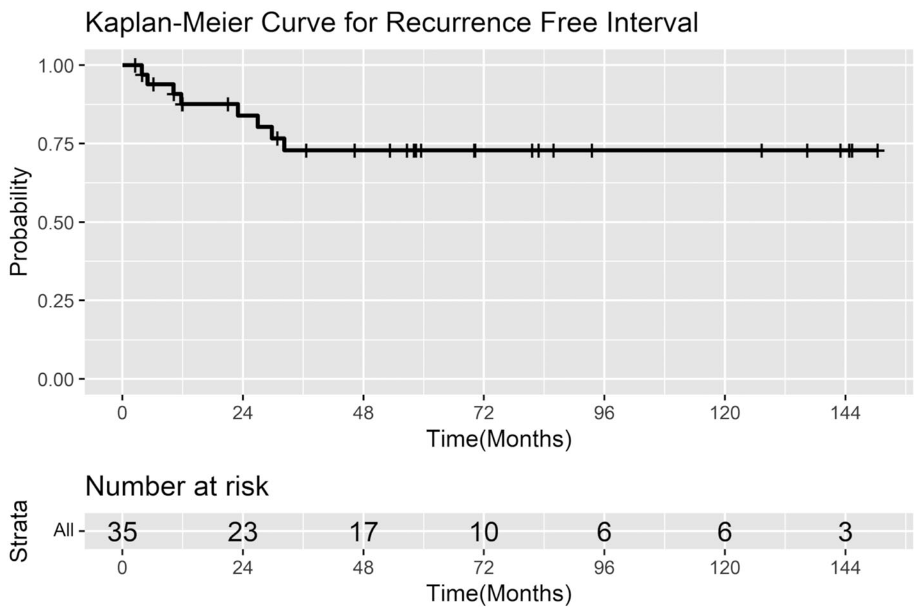

Figure 2 Kaplan–Meier curve for recurrence-free survival. A total of 19 patients (54.3%) experienced recurrence, and the median recurrence-free interval was 22.9 months.

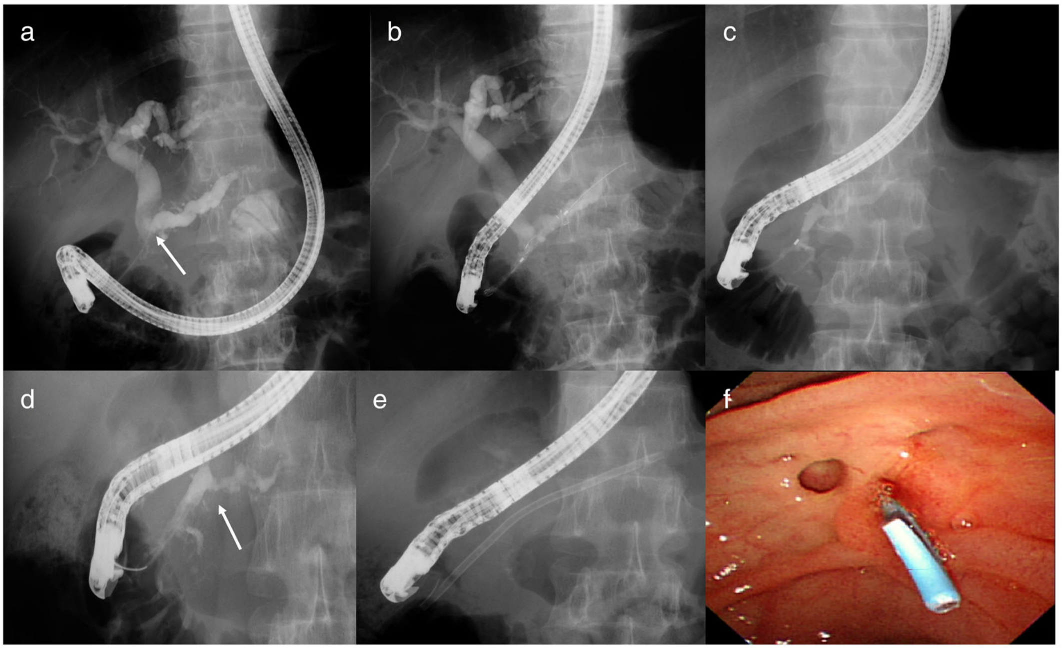

Figure 3 A case with de novo stricture after metal stent insertion. (a) The pancreatogram shows a tight stricture in the head portion of the main pancreatic duct (arrow). (b) Deployment of a fully covered self-expandable pancreatic metal stent. (c) Resolution of the pancreatic duct stricture after removal of the metal stent. (d) A stent-induced de novo stricture was observed during follow-up. (e) A longer plastic stent was placed across the de novo stricture site. (f) Endoscopic view of the inserted plastic stent.

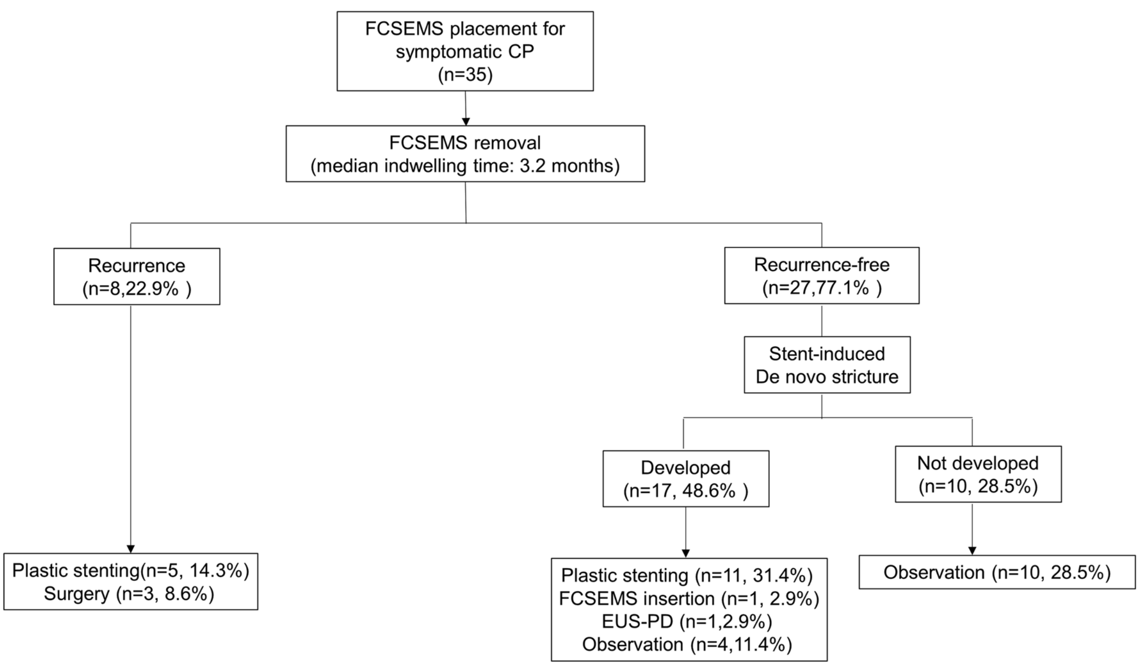

Figure 4 Flowchart of the treatment and follow-up strategy in this study. CP, chronic pancreatitis; EUS-PD, endoscopic ultrasound guided pancreatic duct drainage; FCSEMS, fully covered self-expandable metal stent.

Table 3 Studies of the past 10 years *vs* the present study on FCSEMS for chronic pancreatitis

Author, year	Patients, *N*	Stent type	Diameter (mm)	Length (cm)	Planned stent removal (months)	Stricture resolution, % (*n*/*N*)	Symptom recurrence rate after stent removal, % (*n*/*N*)	Follow-up duration (months)	FCSEMS-related adverse events, % (*n*/*N*)
Giacino et al., 2012[23]	10	WallFlex/WallStent	8, 10	4, 6, 8	6	100(10/10)	40.0(4/10)	20(mean)	20.0 (2/10) cholangitis 20.0 (2/10) impaction of stent, distal end
Ogura et al., 2016[21]	13	Niti-S, S-type	6	6, 8	6	100(13/13)	23.1(3/13)	9(median)	15.3 (2/13) stent migration 7.7 (1/13) severe abdominal pain
Matasubara et al., 2016[12]	10	Niti-S, Bumpy	8, 10	5–10	3	80(8/10)	70(7/10)	35 (median)	20.0 (2/10) stent migration 20.0 (2/10) suppurative pancreatic ductitis 20.0 (2/10) stent-induced de novo stricture
Tringali et al., 2018[11]	15	Niti-S, Bumpy	6, 8	3, 4, 5	6	93.3(14/15)	11.1(1/9)†	39(mean)	46.7 (7/15) stent migration 26.7 (4/15) stent-induced de novo stricture 10.0 (1/10)‡ cholangitis
Oh et al., 2018[17]	18	Niti-S, Bumpy	7.5	5, 6, 7, 8	6	83.3(15/18)	13.3(2/15)	47(median)	16.7 (3/18) severe abdominal pain
Sharaiha et al., 2019[9]	33	WallFlex	8, 10	N/A	3	87.9(29/33)	36.3(12/33)	14(mean)	18.2 (6/33) severe abdominal pain 6.1 (2/33) cholangitis 3.0 (1/33) impaction of stent, distal end
Korpela et al., 2019[10]	17	Niti-S, Bumpy/Hanaro/Viabil	8, 10	3, 4, 6	5	70.6(12/17)	30.0(3/10)†	29(median)	11.7 (2/17) severe abdominal pain 17.6 (3/17) post-ERCP pancreatitis 41.1 (7/17) stent migration
Lee et al., 2020[24]	25	Bonastent, M-Intraductal	8, 10	3, 5	3	100(25/25)	12.0(3/25)	34(median)	4.0 (1/25) stent migration
Present study, 2022	35	Niti-S, Bumpy	6, 8, 10	4–8	3	100(35/35)	54.3(19/35)	136(median)	5.7 (2/5) cholangitis 48.6 (17/35) stent-induced de novo stricture

ERCP, endoscopic retrograde cholangiopancreatography; FCSEMS, fully covered self-expandable metal stent; N/A, not available.
†Patients lost to follow-up were excluded;
‡Patients who received FCSEMS through the major papilla.

FCSEMSs have several advantages over plastic stents. They are less likely to be obstructed based on their larger diameter, thus increasing the dilating properties within strictures.[22] With its superior pushability derived from the higher flexibility of the pushing catheter,[23] it can cross the stricture easier and save time compared with deploying multiple plastic stents. In previous studies evaluating FCSEMSs in MPD strictures, the technical and clinical success rates were 100% and 30–88.9%, respectively (Table 3).[9,10,12,17,21,24] However, there is a paucity of studies investigating long-term outcomes of FCSEMSs in patients with chronic pancreatitis.

In our study, technical success was 100%. As all included patients had received plastic stent placement previously, FCSEMS placement was easier compared with that in patients who undergo stent placement for the first time. Although complete radiological success was only achieved in two patients (6.1%), overall radiological success was achieved in all patients in the present study. We speculate that the low complete radiological success rate was due to the relatively short median stent indwelling time of 3.2 months. In our previous study, the FCSEMSs were maintained for a median of 7.5 months, which was associated with a complete radiological success rate of 83.3%.[17] The optimal FCSEMS placement indwelling time for benign pancreatic strictures has not yet been elucidated. Although a longer stent indwelling time may be associated with a higher stricture resolution rate, metal stent removal may be considered difficult.[17] In a study by Giacino et al.,[23] FCSEMS removal failed in two of 10 patients due to FCSEMS impaction after 6 and 9 months. Therefore, further prospective studies for evaluating the optimal FCSEMS indwelling time are required.

Clinical success was achieved in 82.9% of patients. Eighteen patients (51.4%) were able to stop analgesic treatment. Based on our results and those of previous reports, symptomatic improvement was associated with stricture improvement in patients with FCSEMS placement.[17] The results of this study demonstrate favorable efficacies in terms of short-term clinical outcomes, including both radiologic and clinical success.

The investigation of long-term outcomes of FCSEMS placement in chronic pancreatitis patients with refractory strictures is important to optimize therapeutic strategies. Previous studies have reported that sustained pain relief after FCSEMS removal was maintained in 85–100% of patients during short-term follow-up (mean, 5–20 months).[14,21,23,25] However, in the longer term (mean, 29–39 months), symptomatic stricture recurrence ranged between 11.1 and 70.0% (Table 3). Here, symptomatic stricture recurrence was observed in 22.9% of patients during a median follow-up period of 136 months. The median stricture recurrence-free interval was 24.9 months. Considering that previous plastic stent placement failed for the patients included in our study, FCSEMS placement appears to be a reasonable alternative treatment in patients with chronic pancreatitis with refractory strictures.

Prospective comparative studies have shown that surgery was superior to endoscopic treatment for pain relief in patients with chronic pancreatitis.[6,26] However the patients' characteristics between aforementioned studies and this study are different: Patients in those studies were naive to endoscopic treatment, whereas all of patients in this cohort had persisted pancreatic stricture despite of plastic stent placement. And at time our patients underwent FCSEMS placement, most of them were reluctant to pancreatic surgery; therefore, surgery was performed in only selected patients. Furthermore, surgical treatment is rarely regarded as first-line therapy considering its invasiveness even recent days.[27] Further studies comparing surgical treatment and upfront FCSEM insertion for patients with symptomatic chronic pancreatitis should be warranted.

Stent-induced de novo strictures resulted in reactive hyperplasia secondary to compression from the flared end of the FCSEMS.[16] Although recent long-term follow-up studies reported the occurrence of stent-induced de novo strictures in 25–27% of cases,[12,16] the clinical significance of such strictures remains uncertain. In our previous study, stent-induced de novo stricture developed in five of 32 patients (15.6%) during a mean follow-up of 5 months,[14] at the end of which these patients were asymptomatic. However, in the present study, stent-induced de novo strictures were identified in 17 of our current study patients (48.6%), which is a higher than reported in previous studies.[12,17,28] The unique flared ends structure of the FCSEMSs, which prevent stent migration, may have caused ischemic injury arising from the excessive compression of the MPD due to outward radial forces. By univariable analysis, FCSEMSs with larger diameter showed a tendency to develop de novo strictures. Although small number of patients may not guarantee the significance of stent diameter, excessive radial force from large diameter could have synergistic effect with flared ends stricture for development of stent-induced de novo strictures. Hence, it is necessary to develop stent structures in the future that will not damage the MPD while at the same time maintaining the appropriate level of radial forces to prevent migration. Recently, a newly developed intraductal FCSEMS with a nonflared, different diameter in its middle portion was introduced by Lee et al.[24] These newly developed stents were reported to be associated with a lower rate of adverse events, with a migration rate of only 4% and an absence of de novo strictures. Notably however, data on these intraductal FCSEMSs are still insufficient. Further prospective studies with larger numbers of patients will be crucial for the optimization of FCSEMS use in pancreatic ductal stenting.

Our study has several limitations. First, it is retrospective in nature, and the number of included patients was relatively small. Second, this study was conducted in a single center that did not compare FCSEMS-derived results with those of multiple plastic stent placement. Third, change of alcohol and smoking habit were not evaluated, which is important factor regarding chronic pancreatitis. The impact of alcohol or tobacco use on the progression of chronic pancreatitis could be illuminated by future prospective studies. Fourth, the inherent structure of the FCSEMSs was found to be associated with a high rate of de novo stricture. The further development of these stents that will reduce the incidence of do novo strictures while maintaining their anti-migration features are therefore warranted. Lastly, selection bias was also a major limitation of our present study, as our study protocol allowed for the inclusion of only patients with showing symptomatic improvement after a previous plastic stenting. Further prospective comparative studies with larger sample sizes are required to confirm the long-term clinical efficacy and safety of FCSEMSs for the treatment of refractory pancreatic strictures in patients with chronic pancreatitis.

In conclusion, FCSEMS may be effective for relieving refractory strictures in symptomatic chronic pancreatitis. Although we did not observe FCSEMS migration, stent-induced de novo strictures were associated with FCSEMSs in approximately 48% of patients during follow-up. Long-term prospective studies with a sufficient number of cases are warranted to investigate and validate the clinical efficacy and safety of placing newly developed FCSEMS to treat refractory pancreatic stricture in chronic pancreatitis patients.

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Supporting information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Table S1. Comparison of characteristics and clinical outcomes between recurrence-free and recurrence group.
Table S2. Univariable analysis for development of stent induced de novo strictures.