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Endoscopic ultrasound-guided drainage of pancreatic collections with dedicated metal stents: A nationwide, multicenter, propensity score-matched comparison

Chiara Coluccio[a,*], Antonio Facciorusso[b], Edoardo Forti[c], Germana De Nucci[d], Roberto Di Mitri[e], Thomas Togliani[f], Luigi Cugia[g], Andrew Ofosu[h], Andrea Anderloni[i], Ilaria Tarantino[j], Carlo Fabbri[a], Stefano Francesco Crinò[k], I-eus group[#]

[a] Gastroenterology and Endoscopy Unit, Forlì-Cesena Hospitals, AUSL Romagna, Forlì, 47121, Italy
[b] Section of Gastroenterology, Department of Medical Sciences, University of Foggia, Foggia, 71100, Italy
[c] Operative Endoscopy Unit, Niguarda Ca' Granda Hospital, Milano, 20100, Italy
[d] Department of Gastroenterology, Salvini Hospital, Garbagnate, 20024, Italy
[e] Gastroenterology and Endoscopy Unit, Arnas Civico Hospital, Palermo, 90100, Italy
[f] Gastroenterology and Endoscopy Unit, ASST Carlo Poma, Mantua, 46100, Italy
[g] Gastroenterology and Digestive Endoscopy Department, Azienda Ospedaliero Universitaria Sassari, Sassari, 07100, Italy
[h] Division of Digestive Diseases, University of Cincinnati, Cincinnati, OH, 45219, USA
[i] Endoscopy Unit, First Department of Internal Medicine, Fondazione IRCCS Policlinico San Matteo, University of Pavia, Pavia, 27100, Italy
[j] Endoscopy Service, Department of Diagnostic and Therapeutic Services, ISMETT, Palermo, 90100, Italy
[k] Gastroenterology and Digestive Endoscopy Unit, The Pancreas Institute, University Hospital of Verona, Verona, 37100, Italy

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ABSTRACT

Background: The new dedicated stents for endoscopic ultrasound (EUS)-guided transluminal drainage of peri–pancreatic fluid collections (PFCs) demonstrated optimal efficacy and safety profiles.
Aims: This study aimed to evaluate the safety, technical and clinical success, and recurrence rate of PFCs drained with Lumen Apposing Metal Stent (LAMS) or Bi-Flanged Metal Stent (BFMS).
Methods: Data from a multicenter series of PFCs treated with LAMS or BFMS at 30 Italian centers during a 5-year period were retrieved. The rate of adverse events (AEs), technical success, clinical success, PFC recurrence were evaluated. To overcome biases, a 1-to-1 match was created using propensity score analysis.
Results: Out of 476 patients, 386 were treated with LAMS and 90 with BFMS, with a median follow-up of 290 days (95% CI 244 to 361). Using propensity score matching, 84 patients were assigned to each group. The incidence of AEs did not differ between the two stents (13.1% versus 15.5%, $p = 0.29$), mainly bleeding or recurrence rate (4.7% versus 3.5%, $p = 1$). Technical and clinical success in the BFMS and LAMS groups were 92% versus 95% ($p = 0.36$) and 91% versus 94% ($p = 0.64$), respectively.
Conclusion: Our study demonstrates that LAMS and BFMS have comparable safety profiles with similar technical and clinical success rates for EUS-guided PFC drainage.

1. Introduction

Pancreatic fluid collections (PFCs) are frequent complications of acute pancreatitis (AP) and, less frequently, abdominal trauma or surgery. The updated Atlanta classification categorizes PFCs as acute PFC, pancreatic pseudocysts (PP), acute necrotic collections, and walled-off necrosis (WON) according to the time onset (less than or greater than 4 weeks after AP) and the presence or absence of necrosis. Both PP and WON are surrounded by a detectable capsule on imaging [1].

Drainage of PFCs is indicated in case of documented or suspected infection, abdominal compartment syndrome, or symptoms related to organ compression [2]. Both European and American guidelines recommend endoscopic drainage of PFCs under endoscopic ultrasound (EUS) guidance as first-line therapy, utilizing either polyethylene stents (PS) or Lumen-Apposing Metal Stent (LAMS), with LAMS appearing to be superior to PS [2,3]. Surgery

* Corresponding author at: Gastroenterology and Digestive Endoscopy Unit, Forlì-Cesena Hospitals, AUSL Romagna, Italy.
E-mail address: chiara.coluccio@auslromagna.it (C. Coluccio).
List of Coauthors I-eus group at end of the paper.

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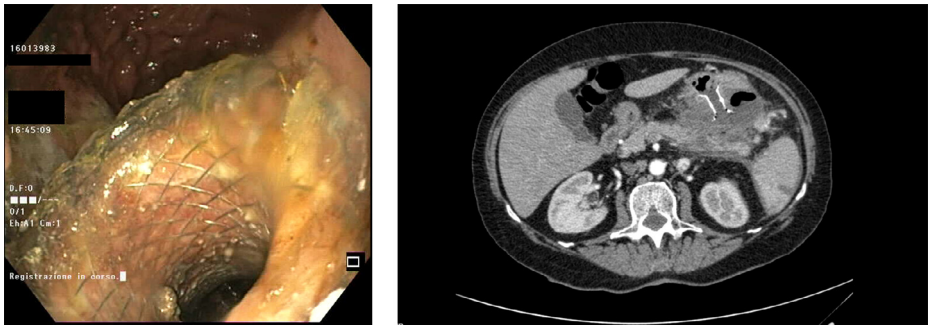

Fig. 1. a) endoscopic view of Niti-s NAGI™ (Taewoong Medical, Gyeonggi-do, Seoul, South Korea) through a pancreatic fluid collection; b) radiologic view of Niti-s NAGI™ (Taewoong Medical, Gyeonggi-do, Seoul, South Korea) through a pancreatic fluid collection.

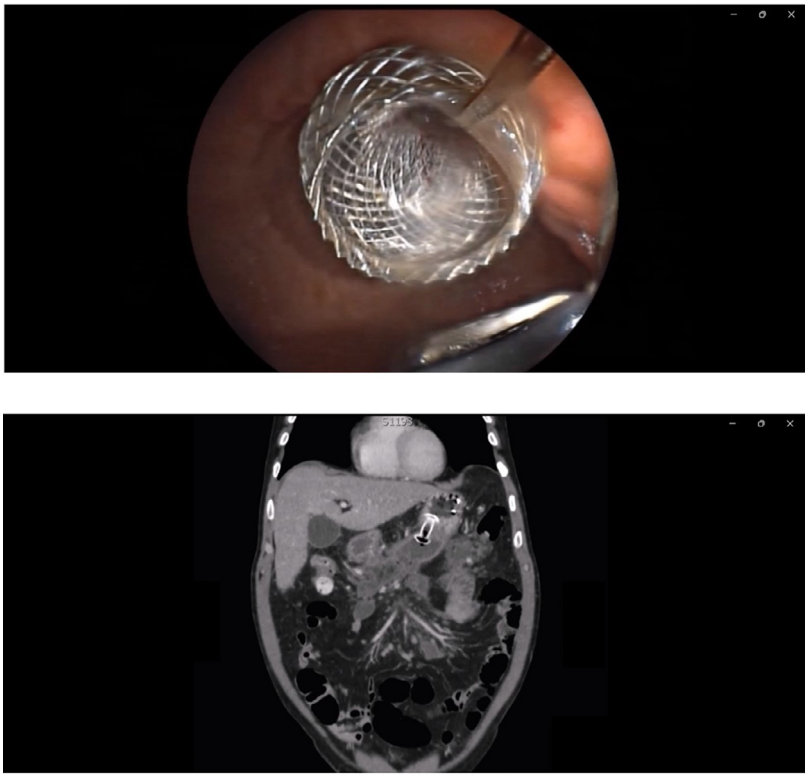

Fig. 2. a) endoscopic view of Hot Axios stent (Boston Scientific, Marlborough, Mass, USA) through a pancreatic fluid collection; b) radiologic view of Hot Axios stent (Boston Scientific, Marlborough, Mass, USA) through a pancreatic fluid collection.

is associated with high morbidity and mortality, whereas percutaneous treatment carries an increased risk of infection and fistula [4–6].

To date, there are several types of LAMS for EUS-guided drainage of PFCs are currently available on the market, but comparative efficacy studies are lacking. In 2013, a specially designed removable and bi-flanged metal stent (BFMS) called Niti-s NAGI™ stent (Taewoong Medical, Gyeonggi-do, Seoul, South Korea) became available, demonstrating good safety and efficacy with a lower rate of stent migration compared to traditional SEMS [7]. (Fig. 1a/b)

During the same time frame [8] a new barbell-shape LAMS (Axios™, Boston Scientific, Marlborough, Mass, USA) equipped with an electrocautery-enhanced (EC) delivery system (Hot-Axios™) was introduced (Fig. 2a/b). This added benefit allows endoscopists to access the target cavity in a single step and deliver stents without the need of fluoroscopy.

Due to their wide diameters, both stents allow the endoscope to be inserted through the stent for direct therapeutic intervention and have high reported technical (89–100%) and clinical (93–100%) success rates for the management of PFCs [9–15]. However, to date, only one retrospective single-center study has compared Nagi™ and Hot-Axios™ for EUS-guided drainage of PFCs [16].

The primary aim of this multicenter study was to evaluate the safety of these two differently tailored stents in a large cohort of patients who underwent EUS-guided PFCs. The secondary aims were technical success, clinical success rate, and recurrence of collection.

2. Methods

2.1. Study design and population

Retrospective data on patients with PFCs treated with EUS-guided placement of LAMS and BFMS were retrieved from an Italian nationwide EUS registry involving 30 secondary and tertiary centers and including all consecutive patients with PFC, both PP and WON, with suspected or proven infection or causing abdomi-

nal symptoms due to compression during a 5-year period (January 2016–July 2020). Patients who underwent PFC drainage with PS or different metal stents were excluded. The Italian nationwide EUS registry included approximately 80% of centers performing these procedures at the time, thereby representing real-world settings. Endoscopists performed EUS-guided drainage with varying levels of expertise. The study was approved by the institutional review board of each participating center (NCT03903523) and performed in accordance with the Declaration of Helsinki.

2.2. Devices and procedures

EUS-guided procedures were performed with a therapeutic echoendoscope, using CO2 insufflation with the patient under deep sedation or general anesthesia administered by an anesthesiologist in accordance with local sedation policies. The procedures were performed in a single session. Under EUS guidance, the fluid collections were examined and drained either trans-gastric or transduodenal. The selection of stent type and size was left to the endoscopist's discretion or dependent on the institution's availability. In this study, all LAMS were Hot-Axios™, and all BFMS were Niti-s NAGI™ stents. Different deployment techniques were utilized based on the stent and endoscopist preference, with or without fluoroscopic guidance. Details on the Nagi™ and Hot-Axios™ stents and technical procedures were reported in Supplementary material (S.1, S.2) [11,14,17-21].

2.3. Data collection

Data were compiled and extracted in a central database. For each procedure, patient-related data, demographics, etiology of pancreatitis causing PFC, size of the PFC, imaging appearance of pancreatic duct and vessels, type and location of PFC, and indications for drainage were collected. In addition, data were collected on the type and size of the used stent, deployment technique, site of approach, use of stent dilation, necrosectomy with hydrogen peroxide or antibiotic irrigation, nasocystic tube or pigtail use, procedural and deployment stent time. Postprocedural data were collected for percutaneous drainage, days to stent indwelling and AEs. In accordance with the discretion of the endoscopist in charge at each participating hospital, patients were observed with periodic laboratory tests and clinic visits.

2.4. Outcomes and definitions

The study's primary outcome was the AE rate, with severity graded according to the American Society for Gastrointestinal Endoscopy (ASGE) lexicon severity grading system [22].

Secondary outcomes included technical and clinical success rates and recurrence of fluid collections. Technical success was defined as completing EUS-guided drainage of PFC drainage with stent placement. Clinical success was defined as PFC size reduction to <2 cm on axial imaging between 2 weeks and 6 months after stent insertion without the need for additional radiologic, endoscopic, or surgical intervention [21].

2.5. Statistical analysis

Categorical variables were reported as the number of cases and percentage, and differences between groups were compared using the Chi-square and McNemar analysis before and after matching. Continuous variables were expressed as median and interquartile range (IQR), and the Mann-Whitney and Wilkoxon-rank test were used to examine differences between groups before and after matching. All analyses were conducted with a two-tailed test, and the significance threshold was assessed at <0.05.

Using propensity score analysis, a 1-to-1 match was generated to eliminate biases caused by the different distribution of covariates among patients treated with the two types of stent.. The propensity score represents the probability of each individual patient being assigned to a particular condition in a study given a set of known covariates [23]. A multivariate logistic regression was constructed to predict the probability of each individual patient being assigned one of the two groups based on covariates that are known to be able to affect postoperative outcomes, including PFC type (whether pseudocyst or WON), imaging appearance of the pancreatic duct and vessels (leak versus no leak versus unknown), approach (transduodenal versus transgastric), the endoscopic appearance of the cavity (purulent fluid versus solid debris versus other), use of hydrogen peroxide irrigation, use of necrosectomy, use of nasocystic drainage tube, use of pigtail stents through the LAMS. The predictive values were then used to obtain a 1-to-1 match by using the nearest neighbor matching within a specified caliper distance. Nearest neighbor matching within a specified caliper distance selects for matching an untreated subject whose propensity score is closest to that of the treated subject ("nearest neighbor matching" approach) with the further restriction that the absolute difference in the propensity scores of matched subjects must be below some pre-specified threshold (the caliper distance) [24,25]. Thus, patients for whom the propensity score could not be matched because a greater caliper distance were excluded from further analysis. As suggested by Austin, a caliper of width equal to 0.2 of the standard deviation of the logit of the propensity score was used, as this value has been found to minimize the mean squared error of the estimated treatment effect [24].

The statistical analysis was performed using the R Statistical Software 3.0.2′s MatchIt package (Foundation for Statistical Computing, Vienna, Austria).

3. Results

3.1. Study population

In total, 476 patients with PFCs underwent EUS-guided drainage with dedicated metal stents (386 treated with LAMS and 90 with BFMS). The characteristics of the study population prior to propensity score matching are summarized in Table 1.

84 patients were assigned to each group based on their propensity score (Fig. 3a/b). Table 2 details the baseline characteristics of the two groups after matching by propensity score. The two groups were comparable regarding age, gender, PFC type, size, and location. As anticipated, technical variations in stent deployment were observed (e.g., PFC access, use of fluoroscopy guide, and second flange deployment). In addition, the median time to stent removal was comparable between the two groups (45 days, 33.5–58.5 days for LAMS, and 43 days, 30–116 days for BFMS; $p = 0.94$). The median duration of follow-up was 290 days (95 percent CI 244 to 361).

3.2. Outcomes

A detailed list of the outcomes analyzed in this study is reported in Table 3. The two stents did not differ regarding the AE rate (13.1% in the LAMS versus 15.5% in the BFMS group, $p = 0.29$). Overall, 11 (13.1%) AEs were observed in the LAMS group, of which three (3.5%) were mild, four (4.7%) were moderate, three (3.5%) were severe, and one (1.1%) was fatal, whereas 13 AEs (15.5%) were registered in the BFMS group, of which three (3.5%), five (5.9%), three (3.5%), and two (2.3%) mild, moderate, severe, and fatal, respectively ($p = 0.63$). The most common AE was bleeding (5.9% in both groups), followed by infection (4.7% in both groups). Less frequent were stent occlusion (one case in the BFMS group), stent

Table 1
Baseline patients' characteristics and outcomes before propensity score matching.

Variable	Total (n = 476)	LAMS (n = 386)	BFMS (n = 90)	p value
Age (years)	62 (52.1–74)	62 (49.5–73)	63 (50–74)	0.40
Gender M	321 (67%)	264 (68%)	57 (63%)	0.42
F	155 (33%)	122 (32%)	33 (37%)	
PFC type				<0.001
Pseudocyst	220 (46%)	162 (42%)	58 (64%)	
WON	256 (54%)	224 (58%)	32 (36%)	
Percentage of necrosis	46 (30–60)	48 (38–60)	42 (30–58)	0.09
Location				0.10
Body	320 (67%)	268 (69%)	52 (58%)	
Head	79 (17%)	59 (15%)	20 (22%)	
Tail	77 (16%)	59 (15%)	18 (20%)	
Collection width (mm)	90 (60–120)	95 (62–115)	88 (56–110)	0.21
Collection length (mm)	75 (52–100)	80 (59–100)	74 (52–96)	0.35
Collection				0.71
Multiloculated	110 (23%)	91 (24%)	19 (21%)	
Single	366 (77%)	295 (76%)	71 (79%)	
Extension to paracolic gutter				0.06
NR	15 (3%)	15 (4%)	0 (0%)	
No	336 (71%)	266 (69%)	70 (78%)	
Yes	125 (26%)	105 (27%)	20 (22%)	
Imaging appearance of PD				<0.001
Leak	32 (7%)	27 (7%)	5 (6%)	
No leak	294 (62%)	217 (56%)	77 (86%)	
Complete disruption	15 (3%)	15 (4%)	0 (0%)	
Unknown	135 (28%)	127 (33%)	8 (9%)	
Vessels appearance on imaging				0.04
No alterations	378 (79%)	296 (77%)	82 (91%)	
Perigastric varices	33 (7%)	31 (8%)	2 (2%)	
Pseudoaneurysm	9 (2%)	8 (2%)	1 (1%)	
Portal vein thrombosis	21 (4%)	20 (5%)	1 (1%)	
Splenic vein thrombosis	35 (7%)	31 (8%)	4 (4%)	
Indication				0.4
Abdominal pain	141 (30%)	114 (30%)	27 (30%)	
Early satiety	36 (8%)	26 (7%)	10 (11%)	
Infection	200 (42%)	162 (42%)	38 (42%)	
Outlet obstruction	58 (12%)	48 (12%)	10 (11%)	
Vessels thrombosis	8 (2%)	8 (2%)	0 (0%)	
Vomiting	15 (3%)	11 (3%)	4 (4%)	
Other	18 (4%)	17 (4%)	1 (1%)	
Etiology of pancreatitis				0.52
Alcohol	91 (19%)	74 (19%)	17 (19%)	
Biliary	236 (50%)	198 (51%)	38 (42%)	
Idiopathic	60 (13%)	45 (12%)	15 (17%)	
Post-ERCP	23 (5%)	17 (4%)	6 (7%)	
Post-operative	13 (3%)	11 (3%)	2 (2%)	
Trauma	39 (8%)	29 (8%)	10 (11%)	
Other	14 (3%)	12 (3%)	2 (2%)	
Access				<0.001
Needle/cystotome+guidewire	90 (20%)	0 (0)	90 (100%)	
Single stage	386 (80%)	386 (100%)	0 (0)	
Fluoroscopic guide				<0.001
Yes	163 (34%)	89 (23%)	74 (82%)	
No	313 (66%)	297 (77%)	16 (18%)	
Stent diameter (mm)				0.48
<15	339 (71%)	61 (16%)	26 (29%)	
15–16	87 (18%)	275 (71%)	64 (71%)	
>16	50 (11%)	50 (13%)	0 (0%)	
Number of stents				0.23
1	465 (98%)	375 (97%)	90 (100%)	
2	11 (2%)	11 (3%)	0 (0%)	
Second flange deployment				<0.001
Endoscopic view	135 (28%)	67 (17%)	68 (76%)	
Intrachannel	341 (72%)	319 (83%)	22 (24%)	
Approach				0.004
Transduodenal	37 (8%)	24 (6%)	13 (14%)	
Transgastric	428 (90%)	354 (92%)	74 (82%)	
Both	1 (0.2%)	1 (0.2%)	0 (0%)	
Other	8 (1.4%)	7 (1.8%)	1 (1.5%)	
Not reported	2 (0.4%)	0 (0%)	2 (2.5%)	
Stent dilation				<0.001
No	375 (79%)	290 (75%)	85 (94%)	
Yes	101 (21%)	96 (25%)	5 (6%)	

(*continued on next page*)

Table 1 (*continued*)

Variable	Total (n = 476)	LAMS (n = 386)	BFMS (n = 90)	p value
Necrosectomy				<0.001
No	277 (57.6%)	201 (51.6%)	76 (84%)	
Yes	198 (42%)	184 (48%)	14 (16%)	
Not reported	1 (0.4%)	1 (0.4%)	0 (0%)	
Endoscopic appearance of cavity				<0.001
Purulent fluid	209 (44%)	169 (44%)	40 (44%)	
Solid debris	156 (33%)	140 (36%)	16 (18%)	
Vessels	11 (2.2%)	11 (3%)	0 (0%)	
Other	91 (19%)	57 (15%)	34 (38%)	
Not reported	9 (1.8%)	9 (2%)	0 (0%)	
Hydrogen peroxide irrigation				<0.001
No	329 (69%)	246 (64%)	83 (92%)	
Yes	136 (29%)	129 (33%)	7 (8%)	
Not reported	11 (2%)	11 (3%)	0 (0%)	
Antibiotic irrigation				0.08
No	446 (94%)	357 (92%)	89 (99%)	
Yes	19 (4%)	18 (5%)	1 (1%)	
Not reported	11 (2%)	11 (3%)	0 (0%)	
Nasocystic tube drainage				<0.001
No	402 (84%)	336 (87%)	66 (73%)	
Yes	63 (13%)	39 (10%)	24 (27%)	
Not reported	11 (2%)	11 (3%)	0 (0%)	
Pigtail use through stent				<0.001
No	411 (86%)	322 (83%)	89 (99%)	
Yes	65 (14%)	64 (17%)	1 (1%)	
Need of percutaneous drainage				0.54
No	457 (96%)	369 (96%)	88 (98%)	
Yes	19 (4%)	17 (4%)	2 (2%)	
Days to stent removal	30 (21–48)	30 (21–43)	45 (30–117)	<0.001
Procedural time	25 (16–40)	27 (17–40)	19 (15–38)	0.01
Technical success	464 (97%)	378 (98%)	86 (96%)	0.25
Clinical success	440 (92%)	355 (92%)	85 (94%)	0.56
Collection recurrence	30 (6%)	26 (7%)	4 (4%)	0.75
Adverse event rate	71 (15%)	56 (15%)	15 (17%)	0.72

Continuous variables were reported as median values and interquartile range. Comparisons were performed with Mann-Whitney U test for continuous variables and Fisher exact test for categorical ones.
Abbreviations: LAMS, Lumen Apposing Metal Stent; BFMS, Bi-Flanged Metal Stent; PD, pancreatic duct, PFC, pancreatic fluid collection; NR, not reported, WON, walled-off necrosis, ERCP, Endoscopic Retrograde Cholangio-Pancreatography.
Significances were reported in bold.

migration (one case in each group), and perforation (one case in the LAMS group and two cases in the BFMS group; $p = 0.18$).

Technical and clinical successes were 91.7% and 90.5% versus 95.2% and 94.0%, $p = 0.36$ and $p = 0.64$, respectively, in the LAMS and BFMS stent groups. Recurrence of the fluid collection was observed in four cases after LAMS (4.7%) and three cases (3.5%) after BFMS stent placement ($p = 1.0$).

4. Discussion

Historically, PFCs have been drained utilizing double pigtail PS. Recent studies have demonstrated that the use of large-bore, fully-covered metal stents can improve patient outcomes and permit direct endoscopic necrosectomy, particularly in cases of WON (DEN). Bapaye et al. [26] retrospectively compared 133 patients who underwent WON drainage with multiple PS or BFMS (20 mm long, 16 mm diameter Nagi^{TM} stent). BFMS appeared superior to multiple PS in terms of clinical success, the number of sessions for necrosectomy, AEs, the need for salvage surgery, and hospital stay. This finding was also supported by a recent meta-analysis [27] which demonstrated that using LAMS/BFMS resulted in superior clinical outcomes compared to PS in patients with WON, with comparable AEs and technical failure.

Nonetheless, a recent single-center, randomized, controlled trial published by Karstensen et al. [28] showed that LAMS was not superior to double pigtail PS for treatment of large WON (>15 cm), considering a comparable need for DEN and hospital stay, with no apparent difference in AEs, thus suggesting that further evidence are required to definitively establish the superiority of large-bore metal stents over double pigtail PS.

In recent years, LAMS has evolved and changed shape, and efforts have been made to simplify and make the drainage procedure safer. A significant breakthrough was the development of electrocautery delivery systems that allow fluoro-less deployment [17,29-31]. Indeed, EC-LAMS are widely perceived as technically easier to deploy than FCSEMS or PS, which require multiple procedure steps. However, some concerns remain regarding their routine use, including costs, AEs, and, sometimes, unsatisfactory resolution rates [10,32]. Moreover, the superiority of EC-LAMS over BFMS has not been demonstrated.

On the other hand, using BFMS could be theoretically associated with an increased risk of stent displacement during necrosectomy and stent ingrowth precluding removal. The presumed higher risk of displacement of BFMS compared to EC-LAMS has also been raised by a recent study [33] that compared the anchoring force of different LAMS, with Nagi demonstrating the lowest anchoring force and the Axios the highest. However, a large study evaluating the use of Nagi stents in 205 WOPN reported a technical success of 99% and a clinical success of 74.6%, with a low rate of AEs (3.9%) [34].

To demonstrate the superiority of LAMS over BFMS, we conducted a multicenter study including a large number of PFCs. To reduce the risk of selection bias, we employed the propensity score analysis to obtain well-balanced groups for many variables that could influence technical and clinical success and the risk of AEs. In the current study, there were no statistically

Table 2
Baseline patients' characteristics and outcomes after propensity score matching.

Variable	Total (n = 168)	LAMS (n = 84)	BFMS (n = 84)	p value
Age (years)	62 (52.1–74)	62 (49.5–73)	63 (50–74)	0.40
Gender M	110 (65.4%)	59 (70%)	51 (61%)	0.59
F	58 (34.6%)	25 (30%)	33 (39%)	
PFC type				0.70
Pseudocyst	108 (64%)	51 (61%)	57 (68%)	
WON	60 (36%)	33 (39%)	27 (32%)	
Percentage of necrosis	46 (30–60)	48 (38–60)	45 (30–58)	0.29
Location				0.62
Body	94 (56%)	43 (52%)	51 (61%)	
Head	43 (25.5%)	25 (30%)	18 (21%)	
Tail	31 (18.5%)	16 (17%)	15 (18%)	
Collection width (mm)	90 (60–120)	92 (61–120)	88 (56–110)	0.25
Collection length (mm)	75 (52–100)	78 (55–100)	74 (52–96)	0.37
Collection				0.80
Multiloculated	33 (19.6%)	17 (20%)	16 (19%)	
Single	135 (80.4%)	67 (80%)	68 (81%)	
Extension to paracolic gutter				1.0
No	133 (79%)	66 (78%)	67 (80%)	
Yes	35 (21%)	18 (22%)	17 (20%)	
Imaging appearance of PD				0.19
Leak	10 (6%)	6 (7%)	4 (5%)	
No leak	142 (84.5%)	69 (83%)	73 (87%)	
Unknown	16 (9.5%)	9 (10%)	7 (8%)	
Vessels appearance on imaging				0.29
No alterations	156 (93%)	76 (90%)	80 (94.5%)	
Perigastric varices	3 (1.5%)	2 (2.5%)	1 (1%)	
Portal vein thrombosis	3 (1.5%)	2 (2.5%)	1 (1%)	
Splenic vein thrombosis	6 (4%)	4 (5%)	2 (2.5%)	
Indication				0.26
Abdominal pain	47 (28%)	22 (26%)	27 (32%)	
Early satiety	17 (10%)	7 (9%)	10 (12%)	
Infection	64 (38%)	30 (35%)	34 (40%)	
Outlet obstruction	12 (7%)	3 (4%)	9 (11%)	
Vessels thrombosis	16 (9.5%)	16 (17%)	0 (0%)	
Vomiting	7 (6%)	3 (4%)	4 (5%)	
Other	3 (1.5%)	3 (4%)	0 (0%)	
Etiology of pancreatitis				0.42
Alcohol	31 (18%)	16 (19%)	15 (18%)	
Biliary	76 (45%)	40 (47%)	36 (43%)	
Idiopathic	25 (15%)	10 (12%)	15 (18%)	
Post-ERCP	9 (5%)	3 (4%)	6 (7%)	
Post-operative	6 (4%)	5 (5.5%)	1 (1%)	
Trauma	15 (9%)	6 (8%)	9 (11%)	
Other	6 (4%)	4 (4.5%)	2 (2%)	
Access				<0.0001
Needle+guidewire	84 (50%)	0 (0)	84 (100%)	
Single stage	84 (50%)	84 (100%)	0 (0)	
Fluoroscopic guide				<0.0001
Yes	96 (57%)	12 (14%)	84 (100%)	
No	72 (43%)	72 (86%)	0 (0)	
Stent diameter (mm)				0.25
<15	55 (33%)	29 (35%)	26 (31%)	
15–16	106 (63%)	48 (57%)	58 (69%)	
>16	7 (4%)	7 (8%)	0 (0%)	
Number of stents				0.53
1	167 (99.5%)	83 (98.5%)	84 (100%)	
2	1 (0.5%)	1 (1.5%)	0 (0%)	
Second flange deployment				<0.001
Endoscopic view	83 (49%)	18 (22%)	65 (77%)	
Intrachannel	85 (51%)	66 (78%)	19 (23%)	
Approach				0.13
Transduodenal	33 (20%)	22 (26%)	11 (13%)	
Transgastric	131 (78%)	59 (70%)	72 (86%)	
Other	4 (2%)	3 (4%)	1 (1.5%)	
Stent dilation				0.16
No	153 (91%)	73 (87%)	80 (95%)	
Yes	15 (9%)	11 (13%)	4 (5%)	

(*continued on next page*)

Table 2 (*continued*)

Variable	Total (n = 168)	LAMS (n = 84)	BFMS (n = 84)	p value
Necrosectomy				0.23
No	133 (79%)	62 (74%)	71 (85%)	
Yes	35 (21%)	22 (26%)	13 (15%)	
Endoscopic appearance				0.78
of cavity	72 (43%)	34 (39%)	38 (45%)	
Purulent fluid	37 (22%)	21 (26%)	16 (19%)	
Solid debris	59 (35%)	29 (35%)	30 (36%)	
Other				
Hydrogen peroxide				0.44
irrigation	150 (89%)	73 (87%)	77 (92%)	
No	18 (11%)	11 (13%)	7 (8%)	
Yes				
Antibiotic irrigation				1.0
No	167 (99.5%)	84 (100%)	83 (99%)	
Yes	1 (0.5%)	0 (0%)	1 (1%)	
Nasocystic tube				0.86
drainage	127 (75.5%)	65 (78%)	62 (74%)	
No	41 (24.5%)	19 (22%)	22 (26%)	
Yes				
Pigtail uses through				0.17
stent	160 (95%)	77 (92%)	83 (99%)	
No	8 (5%)	7 (8%)	1 (1%)	
Yes				
Need of percutaneous				0.52
drainage	162 (96%)	80 (96%)	82 (98%)	
No	6 (4%)	4 (4%)	2 (2%)	
Yes				
Days to stent removal	44 (30–97.5)	45 (33.5–58.5)	43 (30–116)	0.94

Continuous variables were reported as median values and interquartile range. Comparisons were performed with Wilcoxon test for continuous variables and McNemar test for categorical ones.
The following demographic, technical and collection-related variables were selected for propensity score calculation:.
PFC Type, imaging appearance of pancreatic duct and vessels, approach, endoscopic appearance of cavity, hydrogen peroxide irrigation, use of necrosectomy, use of nasocystic drainage tube, use of pigtail stents through the LAMS.
Abbreviations: LAMS, Lumen Apposing Metal Stent; BFMS, Bi-Flanged Metal Stent; PD, pancreatic duct, PFC, pancreatic fluid collection; NR, not reported, WON, walled-off necrosis, ERCP, Endoscopic Retrograde Cholangio-Pancreatography.
Significances were reported in bold.

Table 3
Outcomes.

	Total (168 pts)	**LAMS** (84 pts)	**BFMS** (84 pts)	**p value**
Adverse event rate	24 (14.2%)	11 (13.1%)	13 (15.5%)	0.29
Type of adverse event	10 (5.9%)	5 (5.9%)	5 (5.9%)	0.18
Bleeding	8 (4.7%)	4 (4.7%)	4 (4.7%)	
Infection	1 (0.5%)	0 (0%)	1 (1.1%)	
Stent occlusion	2 (1.1%)	1 (1.1%)	1 (1.1%)	
Stent migration	3 (1.7%)	1 (1.1%)	2 (2.3%)	
Perforation				
Severity adverse event				0.63
Mild	6 (3.4%)	3 (3.5%)	3 (3.5%)	
Moderate	9 (5.1%)	4 (4.7%)	5 (5.9%)	
Severe	6 (3.4%)	3 (3.5%)	3 (3.5%)	
Fatal	3 (1.7%)	1 (1.1%)	2 (2.3%)	
Technical success				0.36
	157 (93.4%)	77 (91.7%)	80 (95.2%)	
Clinical success				0.64
	155 (92.2%)	76 (90.5%)	79 (94.0%)	
Collection recurrence				1.0
	7 (4.1%)	4 (4.7%)	3 (3.5%)	

Values are expressed as number (percentage).
Abbreviations: LAMS, Lumen Apposing Metal Stent; BFMS, Bi-Flanged Metal Stent.

significant differences in technical or clinical success between LAMS and BFMS for EUS-guided drainage of PFC (both PP and WON); moreover, the safety profile of the two devices was also comparable.

Overall, a similar rate of AEs was reported in the two groups (13% for LAMS whereas 15% for BFMS, $p = 0.63$), with bleeding representing the most common AE (5.9% in both groups), followed by infection (4.7% in both groups). The predominance of bleeding among AEs is consistent with the findings of the international multicenter analysis by Fugazza et al. [21] on AEs associated with LAMS for PFC drainage. Their study reported bleeding in 27.8% of cases and stent migration in 25.3%. Even in the retrospective study by Chandran et al. [10], stent migration associated with BFMS was not negligible (8.5% in the early phase, 12.8% in the late phase). In contrast, in our results, only 1 case was in each group. Other AEs observed in our series were perforation (1 case in the LAMS group and 2 cases in the BFMS group; $p = 0.18$), stent migration (1 case in each group), and stent occlusion (1 case in the BFMS group), col-

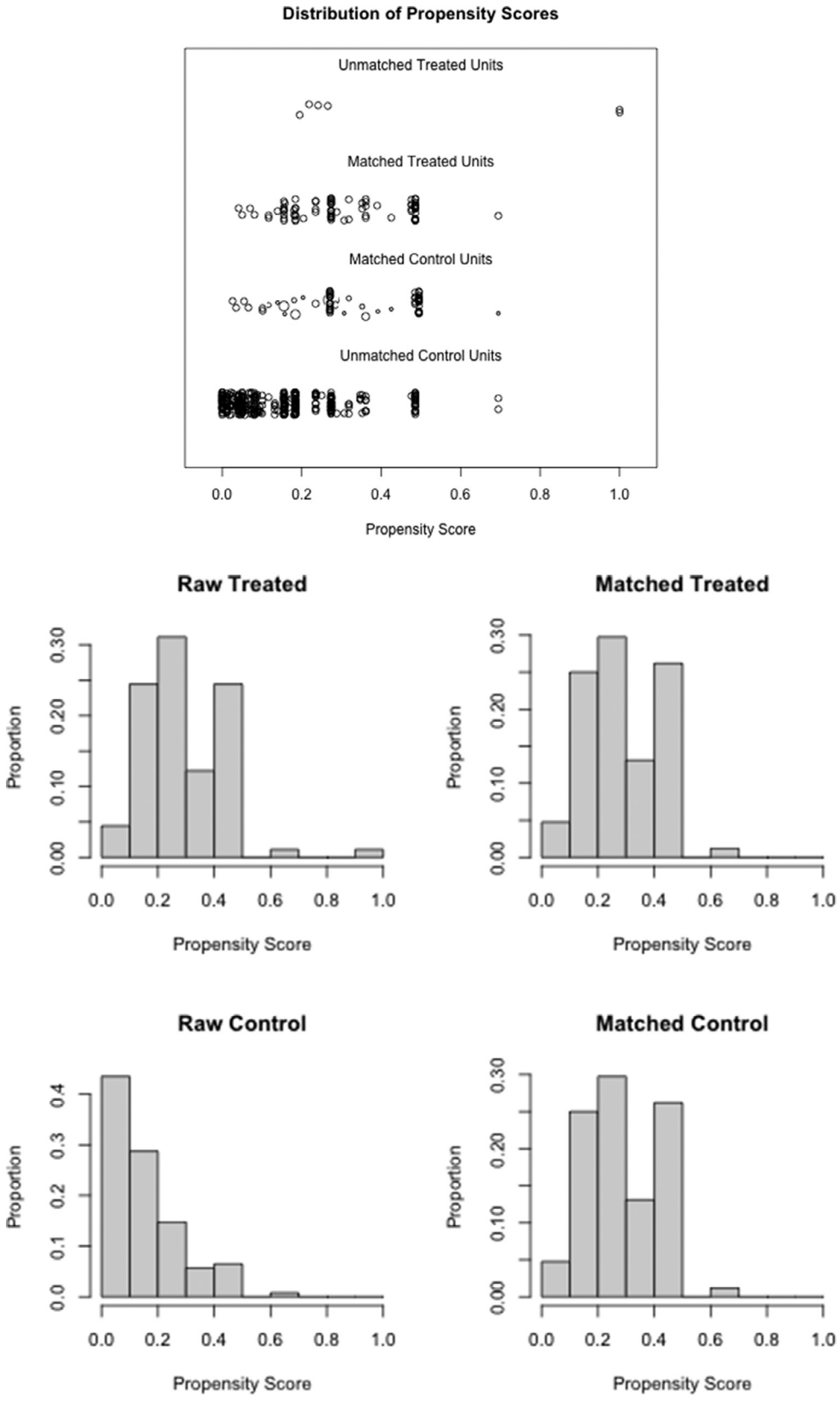

Fig. 3. Propensity score matching. Out of 476 patients with pancreatic fluid collection drained with EUS-guided lumen-apposing metal stent, of which 386 were treated with Hot-Axios, and 90 with Nagi stent after propensity score matching two groups were compared: 84 subjects who underwent EUS-drainage with Hot-Axios and 84 treated with Nagi stent. A. Propensity score matching jitter plot. B Propensity score matching histogram.

lection recurrence was observed in 4 cases after LAMS (4.7%) and 3 cases (3.5%) after BFMS ($p = 1.0$).

Siddiqui et al. [14] in 2016 conducted a large retrospective, multicenter U.S. study to evaluate clinical outcomes and safety of EUS-guided drainage of PFC using LAMS (Axios™) on 82 patients. Results demonstrated high technical and clinical success rates (resolution of pseudocysts and WON of 100% and 88%, respectively). The results of this study appear to be superior to those observed in a case series by Chandran et al. [10]. in which BFMS stents were used to drain 47 PFC, with a resolution rate of 76.6% and a notable rate of AEs (in particular 4 early and 6 late stent migrations). In the study by Chandran et al., a larger subgroup of WON (infected or uninfected) was included, which may account for these differences.

Although LAMS and BFMS stents have a similar design, their minor differences may account for the higher migration rate reported for BFMS, which was not confirmed by our study.

More recently, the same American group [35] conducted an international, multicenter retrospective trial to compare the efficacy and safety of BFMS versus LAMS for endoscopic drainage of WON. No statistically significant differences were found in technical and clinical success or AEs among 387 pts (205 using BFMS with a "step-up approach" and 182 using LAMS with scheduled necrosectomy). The migration rate was higher in the BFMS group than in the LAMS group (15 [7.3%] vs. 3 [1.6%]; $P<0.001$); however, there was no difference between the BFMS and LAMS groups in the clinically significant migration (2.4% vs. 1.6%, respectively; $P = 0.73$). It is essential to note that only the cold version of Axios™ was used in this study. This could have impacted the results, particularly the technical success rate and AEs. Moreover, this represents the main difference with our study (where only EC-LAMS were used), in addition to the significant heterogeneity between the two groups, which was mitigated in our study by propensity score analysis.

To our knowledge, only one study published in 2017 by Bekkali et al. [16] has compared the efficacy of EC-LAMS and BFMS for EUS-guided drainage of PFCs. They demonstrated that, in a retrospective series of 72 patients (40 treated with BFMS, 32 with EC-LAMS), the use of a single-device LAMS is associated with a statistically significant shorter procedure time compared with BFMS, but with overall total procedure costs and technical and clinical outcomes similar for both systems, without significant differences in the rate of AEs, which is supported by our findings. Nevertheless, there are substantial differences between our study and this one: i) the number of patients included was significantly lower than our sample size even after matching; ii) the two groups were not comparable in terms of the different variables, whereas in our study we used a propensity score analysis; iii) a selected population affected only by WON was included, while in our series WON accounted for only one-third of collections.

Our study has a few limitations: first, the retrospective design with non-randomized stent selection poses a risk of selection bias due to the preference/availability of one stent over the other. However, we attempted to limit this bias by employing the propensity score analysis, which assists in overcoming biases caused by the different distribution of covariates among the included patients, thereby adjusting the sample. Second, the multicenter setting, with the participation of several endoscopists with diverse expertise and the different experience of the centers and their facilities of other disciplines, may have resulted in substantial variation in patient management or techniques, which may have negatively impacted certain outcomes. However, it is difficult to standardize these procedures, and the participation of multiple centers makes our results more representative of daily clinical practice nationwide.

Indeed, most previously published studies on this topic originate from single referral centers or involve a small number of expert endoscopists [15,19,36], certainly ensuring better outcomes but presenting a less reproducible picture of real-world conditions. Third, in our study, the majority of stents used had a diameter of 15–16 mm or less, with only 7 cases (8%) using wider LAMS (20 mm Hot-Axios™), despite recent evidence [37–40] supporting the use of larger diameters to favor WON resolution, due to a significant increase in the cross-sectional area for PFC drainage, allowing a quicker resolution of WON as well as enable necrosectomy. The use of these sizes of stents could have slightly influenced our reported outcomes and could account for some discrepancies between them and more recently published series.

On the other hand, this study has notable strengths. The significant number of patients involved, the standardized definition of AEs, and the clear distinction between LAMS and BFMS, which are considered two distinct groups, should not be underestimated. Indeed, several studies group the two types of stents together, despite their slight differences; as a result, the distribution imbalance or the size of each group (which is not always homogenous) might influence the statistical comparison.

In conclusion, although the data is inconclusive regarding which type of stent provides the best outcome for EUS-guided PFC drainage, our study demonstrates that, among dedicated metal stents, EC-LAMS and BFMS have comparable safety profiles with similar technical and clinical success rates, suggesting that the choice of one stent over another should be based on clinical and technical aspects and/or personal expertise, rather than efficacy rate alone.

List of coauthors: I-eus group

Cecilia Binda[1], Maria Chiara Petrone[2], Debora Berretti[3], Raffaele Macchiarelli[4], Mauro Lovera[5], Fabia Attili[6], Francesca D'Errico[7], Mario Luciano Brancaccio[8], Alessandro Redaelli[9], Enrico Tasini[10], Marco Ballarè[11], Franco Coppola[12], Nicola Leone[13], Roberto Grassia[14], Pietro Fusaroli[15], Claudio DeAngelis[16], Fabio Cipolletta[17], Mauro Manno[18], Roberta Badas[19], Valeria Pollino[20], Lorenzo Camellini[21], Laura Bernardoni[22], Elisabetta Conte[23], Andrea Lisotti[15], Massimiliano Mutignani[24], Mario Traina[25], Paolo Giorgio Arcidiacono[2]

[1]Gastroenterology and Endoscopy Unit, Forlì-Cesena Hospitals, AUSL Romagna, Forlì, Italy
[2]PancreatoBiliary Endoscopy and EUS Division, Pancreas Translational and Clinical Research Center, San Raffaele Scientific Institute IRCCS, Milan, Italy
[3]Department for Gastroenterology and Digestive Endoscopy, Academic Center of Udine, Udine, Italy
[4]GastroenterologyUnit, A.O.U.S. Policlinico S.Maria alle Scotte, Siena, Italy
[5]Digestive Endoscopy Unit, Fondazione Poliambulanza Istituto Ospedaliero, Brescia, Italy
[6]Digestive EndoscopyUnit, Fondazione Policlinico Universitario Agostino Gemelli IRCCS, Rome, Italy
[7]Gastroenterology and Endoscopy Unit, General Regional Hospital "F. Miulli", Acquaviva delle Fonti, Bari, Italy
[8]Division of Gastroenterology, S. Maria delle Croci Hospital, Ravenna, Italy
[9]Gastroenterology and Endoscopy Unit, San Gerardo Hospital, Monza, Italy
[10]Gastroenterology and Digestive EndoscopyUnit, 'Santa Chiara' Hospital, Trento, Italy
[11]Department of Gastroenterology, 'Maggiore della Carità' Hospital, Novara, Italy
[12]Digestive Endoscopy Unit, Division of Gastroenterology, ASL TO4, Turin, Italy
[13]Digestive Endoscopy Unit, Humanitas Gradenigo, Turin, Italy

[14]Gastroenterology and Digestive Endoscopy Unit, ASST Cremona, Cremona, Italy
[15]Department of Medical and Surgical Sciences, Gastroenterology Unit, University of Bologna/Hospital of Imola, Imola, Italy
[16]Gastroenterologyand Endoscopy Unit, AOU Città della Salute e della Scienza, University of Turin, Turin, Italy
[17]Division ofGastroenterology, Ospedale del Mare, Naples, Italy
[18]Digestive Endoscopy Unit, USL Modena, Carpi Hospital, Italy
[19]Digestive Endoscopy Unit, University Hospital, Cagliari, Italy
[20]Department of Endoscopic Surgery, Brotzu Hospital, Cagliari, Italy
[21]Unit of Gastroenterology, ASL 5Spezzino, La Spezia, Italy
[22]Diagnostic and Interventional Endoscopy of Pancreas, Pancreas Institute, University of Verona, Italy
[23]Gastroenterology and Endoscopy Unit, Arnas Civico Hospital, Palermo, 90100, Italy
[24]Operative Endoscopy Unit, Niguarda Ca' Granda Hospital, Milano, 20100, Italy
[25]Endoscopy Service, Department of Diagnostic and Therapeutic Services, ISMETT, Palermo, 90100, Italy

Conflict of interest

There is no financial support to this study.

Chiara Coluccio is lecturer for Steris.

Andrea Anderloni is consultant for Boston Scientific, Olympus and Medtronic.

Carlo Fabbri is consultant for Boston Scientific and lecturer for Steris and Q3 Medical.

All the other authors have no conflict of interest to declare.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.dld.2023.07.012.

References

[1] Banks PA, Bollen TL, Dervenis C, Gooszen HG, Johnson CD, Sarr MG, et al. Classification of acute pancreatitis–2012: revision of the Atlanta classification and definitions by international consensus. Gut 2013;62(1):102–11 Epub 20121025PubMed PMID: 23100216. doi:10.1136/gutjnl-2012-302779.
[2] Arvanitakis M, Dumonceau JM, Albert J, Badaoui A, Bali MA, Barthet M, et al. Endoscopic management of acute necrotizing pancreatitis: European Society of Gastrointestinal Endoscopy (ESGE) evidence-based multidisciplinary guidelines. Endoscopy 2018;50(5):524–46 Epub 20180409PubMed PMID: 29631305. doi:10.1055/a-0588-5365.
[3] Baron TH, DiMaio CJ, Wang AY, Morgan KA. American Gastroenterological Association clinical practice update: management of pancreatic necrosis. Gastroenterology 2020;158(1):67–75 .e1. Epub 20190831PubMed PMID: 31479658. doi:10.1053/j.gastro.2019.07.064.
[4] Tyberg A, Karia K, Gabr M, Desai A, Doshi R, Gaidhane M, et al. Management of pancreatic fluid collections: a comprehensive review of the literature. World J Gastroenterol 2016;22(7):2256–70 PubMed PMID: 26900288; PubMed Central PMCID: PMC4735000. doi:10.3748/wjg.v22.i7.2256.
[5] Nabi Z, Basha J, Reddy DN. Endoscopic management of pancreatic fluid collections-revisited. World J Gastroenterol 2017;23(15):2660–72 PubMed PMID: 28487603; PubMed Central PMCID: PMC5403745. doi:10.3748/wjg.v23.i15.2660.
[6] Teoh AY, Dhir V, Jin ZD, Kida M, Seo DW, Ho KY. Systematic review comparing endoscopic, percutaneous and surgical pancreatic pseudocyst drainage. World J Gastrointest Endosc 2016;8(6):310–18 PubMed PMID: 27014427; PubMed Central PMCID: PMC4804189. doi:10.4253/wjge.v8.i6.310.
[7] Yao Y, Zhang D, Guo J, Qi K, Li F, Zhu J, et al. A novel self-expanding biflanged metal stent vs tubular metal stent for EUS-guided transmural drainage of pancreatic pseudocyst: a retrospective, cohort study. Medicine (Baltimore) 2019;98(3):e14179 PubMed PMID: 30653165; PubMed Central PMCID: PMC6370115. doi:10.1097/md.0000000000014179.
[8] Binmoeller KF, Shah J. A novel lumen-apposing stent for transluminal drainage of nonadherent extraintestinal fluid collections. Endoscopy 2011;43(4):337–42 Epub 20110124PubMed PMID: 21264800. doi:10.1055/s-0030-1256127.
[9] Bapaye A, Itoi T, Kongkam P, Dubale N, Mukai S. New fully covered large-bore wide-flare removable metal stent for drainage of pancreatic fluid collections: results of a multicenter study. Dig Endosc 2015;27(4):499–504 Epub 20150206PubMed PMID: 25545957. doi:10.1111/den.12421.
[10] Chandran S, Efthymiou M, Kaffes A, Chen JW, Kwan V, Murray M, et al. Management of pancreatic collections with a novel endoscopically placed fully covered self-expandable metal stent: a national experience (with videos). Gastrointest Endosc 2015;81(1):127–35 Epub 20140802PubMed PMID: 25092104. doi:10.1016/j.gie.2014.06.025.
[11] Itoi T, Nageshwar Reddy D, Yasuda I. New fully-covered self-expandable metal stent for endoscopic ultrasonography-guided intervention in infectious walled-off pancreatic necrosis (with video). J Hepatobiliary Pancreat Sci 2013;20(3):403–6 PubMed PMID: 22926337. doi:10.1007/s00534-012-0551-5.
[12] Mukai S, Itoi T, Sofuni A, Tsuchiya T, Gotoda T, Moriyasu F. Clinical evaluation of endoscopic ultrasonography-guided drainage using a novel flared-type biflanged metal stent for pancreatic fluid collection. Endosc Ultrasound 2015;4(2):120–5 PubMed PMID: 26020046; PubMed Central PMCID: PMC4445169. doi:10.4103/2303-9027.156738.
[13] Sharaiha RZ, Tyberg A, Khashab MA, Kumta NA, Karia K, Nieto J, et al. Endoscopic therapy with lumen-apposing metal stents is safe and effective for patients with pancreatic walled-off necrosis. Clin Gastroenterol Hepatol 2016;14(12):1797–803 Epub 20160514PubMed PMID: 27189914. doi:10.1016/j.cgh.2016.05.011.
[14] Siddiqui AA, Adler DG, Nieto J, Shah JN, Binmoeller KF, Kane S, et al. EUS-guided drainage of peripancreatic fluid collections and necrosis by using a novel lumen-apposing stent: a large retrospective, multicenter U.S. experience (with videos). Gastrointest Endosc 2016;83(4):699–707 Epub 20151026PubMed PMID: 26515956. doi:10.1016/j.gie.2015.10.020.
[15] Gornals JB, De la Serna-Higuera C, Sánchez-Yague A, Loras C, Sánchez-Cantos AM, Pérez-Miranda M. Endosonography-guided drainage of pancreatic fluid collections with a novel lumen-apposing stent. Surg Endosc 2013;27(4):1428–34 Epub 20121212PubMed PMID: 23232994. doi:10.1007/s00464-012-2591-y.
[16] Bekkali N.L.H., Nayar M.K., Leeds J.S., Charnley R.M., Huggett M.T., Oppong K.W. A comparison of outcomes between a lumen-apposing metal stent with electrocautery-enhanced delivery system and a bi-flanged metal stent for drainage of walled-off pancreatic necrosis. Endosc Int Open. 2017;5(12):E1189-e96. Epub 20171121. doi: 10.1055/s-0043-120831. PubMed PMID: 29202002; PubMed Central PMCID: PMC5698007.
[17] Rinninella E, Kunda R, Dollhopf M, Sanchez-Yague A, Will U, Tarantino I, et al. EUS-guided drainage of pancreatic fluid collections using a novel lumen-apposing metal stent on an electrocautery-enhanced delivery system: a large retrospective study (with video). Gastrointest Endosc 2015;82(6):1039–46 Epub 20150523PubMed PMID: 26014960. doi:10.1016/j.gie.2015.04.006.
[18] Petrone MC, Archibugi L, Forti E, Conigliaro R, Di Mitri R, Tarantino I, et al. Novel lumen-apposing metal stent for the drainage of pancreatic fluid collections: an Italian multicentre experience. United European Gastroenterol J 2018;6(9):1363–71 Epub 20180617PubMed PMID: 30386609; PubMed Central PMCID: PMC6206530. doi:10.1177/2050640618785078.
[19] Yamamoto N, Isayama H, Kawakami H, Sasahira N, Hamada T, Ito Y, et al. Preliminary report on a new, fully covered, metal stent designed for the treatment of pancreatic fluid collections. Gastrointest Endosc 2013;77(5):809–14 Epub 20130226PubMed PMID: 23453183. doi:10.1016/j.gie.2013.01.009.
[20] Irani S, Baron TH, Grimm IS, Khashab MA. EUS-guided gallbladder drainage with a lumen-apposing metal stent (with video). Gastrointest Endosc 2015;82(6):1110–15 Epub 20150702PubMed PMID: 26142558. doi:10.1016/j.gie.2015.05.045.
[21] Fugazza A, Sethi A, Trindade AJ, Troncone E, Devlin J, Khashab MA, et al. International multicenter comprehensive analysis of adverse events associated with lumen-apposing metal stent placement for pancreatic fluid collection drainage. Gastrointest Endosc 2020;91(3):574–83 Epub 20191120PubMed PMID: 31759037. doi:10.1016/j.gie.2019.11.021.
[22] Cotton PB, Eisen GM, Aabakken L, Baron TH, Hutter MM, Jacobson BC, et al. A lexicon for endoscopic adverse events: report of an ASGE workshop. Gastrointest Endosc 2010;71(3):446–54 PubMed PMID: 20189503. doi:10.1016/j.gie.2009.10.027.
[23] Austin PC. A critical appraisal of propensity-score matching in the medical literature between 1996 and 2003. Stat Med 2008;27(12):2037–49 PubMed PMID: 18038446. doi:10.1002/sim.3150.
[24] Austin PC. An introduction to propensity score methods for reducing the effects of confounding in observational studies. Multivariate Behav Res 2011;46(3):399–424 Epub 20110608PubMed PMID: 21818162; PubMed Central PMCID: PMC3144483. doi:10.1080/00273171.2011.568786.
[25] Facciorusso A, Di Maso M, Antonino M, Del Prete V, Panella C, Barone M, et al. Polidocanol injection decreases the bleeding rate after colon polypectomy: a propensity score analysis. Gastrointest Endosc 2015;82(2):350–8 e2. Epub 20150422PubMed PMID: 25910664. doi:10.1016/j.gie.2015.01.003.
[26] Bapaye A, Dubale NA, Sheth KA, Bapaye J, Ramesh J, Gadhikar H, et al. Endoscopic ultrasonography-guided transmural drainage of walled-off pancreatic necrosis: comparison between a specially designed fully covered bi-flanged metal stent and multiple plastic stents. Dig Endosc 2017;29(1):104–10 Epub 20160913PubMed PMID: 27463528. doi:10.1111/den.12704.
[27] Calo NC, Bishay K, Yaghoobi M, Yuan Y, Mosko J, May G, et al. Comparative Effectiveness of Lumen-Apposing Metal Stents and Plastic Stents for the Treatment of Pancreatic Walled-Off Necrosis: a Meta-analysis. J Can Assoc Gastroenterol 2022;5(2):68–78 Epub 20210807PubMed PMID: 35368320; PubMed Central PMCID: PMC8972216. doi:10.1093/jcag/gwab024.
[28] Karstensen JG, Novovic S, Hansen EF, Jensen AB, Jorgensen HL, Lauritsen ML,

et al. EUS-guided drainage of large walled-off pancreatic necroses using plastic versus lumen-apposing metal stents: a single-centre randomised controlled trial. Gut 2022 Epub 20221129PubMed PMID: 36446550. doi:10.1136/gutjnl-2022-328225.

[29] Khan S, Chandran S, Chin J, Karim S, Mangira D, Nasr M, et al. Drainage of pancreatic fluid collections using a lumen-apposing metal stent with an electrocautery-enhanced delivery system. J Gastroenterol Hepatol 2021;36(12):3395–401 Epub 20210819PubMed PMID: 34370869. doi:10.1111/jgh.15658.

[30] Venkatachalapathy SV, Bekkali N, Pereira S, Johnson G, Oppong K, Nayar M, et al. Multicenter experience from the UK and Ireland of use of lumen-apposing metal stent for transluminal drainage of pancreatic fluid collections. Endosc Int Open 2018;6(3):E259 -e65. Epub 20180228PubMed PMID: 29497684; PubMed Central PMCID: PMC5829997. doi:10.1055/s-0043-125362.

[31] Yoo J, Yan L, Hasan R, Somalya S, Nieto J, Siddiqui AA. Feasibility, safety, and outcomes of a single-step endoscopic ultrasonography-guided drainage of pancreatic fluid collections without fluoroscopy using a novel electrocautery-enhanced lumen-apposing, self-expanding metal stent. Endosc Ultrasound 2017;6(2):131–5 PubMed PMID: 28440239; PubMed Central PMCID: PMC5418966. doi:10.4103/2303-9027.204814.

[32] Chandrasekhara V, Barthet M, Devière J, Bazerbachi F, Lakhtakia S, Easler JJ, et al. Safety and efficacy of lumen-apposing metal stents versus plastic stents to treat walled-off pancreatic necrosis: systematic review and meta-analysis. Endosc Int Open 2020;8(11):E1639 -e53. Epub 20201022PubMed PMID: 33140020; PubMed Central PMCID: PMC7584468. doi:10.1055/a-1243-0092.

[33] Takasaki Y, Isayama H, Shin KS, Ishii S, Fujisawa T, Moon JP, et al. Measurement of the anchoring force of covered self-expandable and lumen-apposing metal stents for interventional endoscopic ultrasonography. Dig Endosc 2023;35(1):96–102 Epub 20220825PubMed PMID: 35837746. doi:10.1111/den.14406.

[34] Lakhtakia S, Basha J, Talukdar R, Gupta R, Nabi Z, Ramchandani M, et al. Endoscopic "step-up approach" using a dedicated biflanged metal stent reduces the need for direct necrosectomy in walled-off necrosis (with videos). Gastrointest Endosc 2017;85(6):1243–52 Epub 20161111PubMed PMID: 27845053. doi:10.1016/j.gie.2016.10.037.

[35] Siddiqui A, Naveed M, Basha J, Lakhtakia S, Nieto J, Shah J, et al. International, multicenter retrospective trial comparing the efficacy and safety of bi-flanged versus lumen-apposing metal stents for endoscopic drainage of walled-off pancreatic necrosis. Ann Gastroenterol 2021;34(2):273–81 Epub 20210104PubMed PMID: 33654370; PubMed Central PMCID: PMC7903561. doi:10.20524/aog.2021.0570.

[36] Itoi T, Binmoeller KF, Shah J, Sofuni A, Itokawa F, Kurihara T, et al. Clinical evaluation of a novel lumen-apposing metal stent for endosonography-guided pancreatic pseudocyst and gallbladder drainage (with videos). Gastrointest Endosc 2012;75(4):870–6 Epub 20120131PubMed PMID: 22301347. doi:10.1016/j.gie.2011.10.020.

[37] Parsa N, Nieto JM, Powers P, Mitsuhashi S, Abdelqader A, Hadzinakos G, et al. Endoscopic ultrasound-guided drainage of pancreatic walled-off necrosis using 20-mm versus 15-mm lumen-apposing metal stents: an international, multicenter, case-matched study. Endoscopy 2020;52(3):211–19 Epub 20200130PubMed PMID: 32000275. doi:10.1055/a-1096-3299.

[38] Binda C, Dabizzi E, Anderloni A, Cennamo V, Fiscaletti M, Fugazza A, et al. Single-step endoscopic ultrasound-guided multiple gateway drainage of complex walled-off necrosis with lumen apposing metal stents. Eur J Gastroenterol Hepatol 2020;32(10):1401–4 PubMed PMID: 32804839. doi:10.1097/meg.0000000000001793.

[39] Pinto S, Bellizzi S, Badas R, Canfora ML, Loddo E, Spada S, et al. Direct endoscopic necrosectomy: timing and technique. Medicina (Kaunas) 2021;57(12) Epub 20211128PubMed PMID: 34946249; PubMed Central PMCID: PMC8707414. doi:10.3390/medicina57121305.

[40] Anderloni A, Fabbri C, Nieto J, Uwe W, Dollhopf M, Aparicio JR, et al. The safety and efficacy of a new 20-mm lumen apposing metal stent (lams) for the endoscopic treatment of pancreatic and peripancreatic fluid collections: a large international, multicenter study. Surg Endosc 2021;35(4):1741–8 Epub 20200422PubMed PMID: 32323015. doi:10.1007/s00464-020-07567-8.