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Retrospective Analysis of the Effect of Hand-sewn and Stapler Closure of Pancreatic Stump After Distal Pancreatectomy on the Development of Postoperative Pancreatic Fistula

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ABSTRACT

Aim: Hand-sewn (HS) and stapled closure (ST) of pancreatic stump following distal pancreatectomy are two frequently used techniques. Rates of postoperative pancreatic fistula (POPF) might be associated with stump closure techniques. This study was carried out to determine rates of POPF after distal pancreatectomy and evaluate impact of two closure methods on development of POPF.

Material and Methods: All patients who underwent elective open or laparoscopic distal pancreatectomy for malignant and benign pancreatic pathologies between 2011 and 2021 were retrospectively evaluated. Patients were grouped as Groups HS and ST. POPF was diagnosed and graded according to International Study Group of Pancreatic Fistula guidelines. Rates of biochemical leak and grades of POPF were primary outcome.

Results: There were 44 patients (28 in Group HS and 16 in Group ST) with a mean age of 51.8±15.1 years. Groups were similar in demographic and clinical characteristics (p>0.05). There were 15 patients (53.6%) with a biochemical leak in Group HS. In Group ST, six patients (37.5%) developed biochemical leaks. There was no significant in difference between groups in terms of biochemical leak (p=0.305). No patient in Group ST developed a pancreatic fistula. There was only one case with Grade B POPF in Group HS. We did not detect a significant difference in terms of POPF between groups (p=0.999).

Conclusion: Both techniques had no significant impact on biochemical leak and POPF rates in patients who underwent distal pancreatectomy. Both pancreatic stump closure approaches are equally safe and can be used with similar clinical efficacy.

Keywords: Pancreatectomy; pancreatic fistula; suturing; surgical staplers.

Distal Pankreatektomi Sonrası Pankreas Güdüğünün Manuel Dikiş Yöntemi veya Stapler Yardımıyla Kapatılmasının Postoperatif Pankreatik Fistül Gelişimi Üzerine Etkisinin Retrospektif Analizi

ÖZ

Amaç: Distal pankreatektomiyi takiben pankreatik güdüğünün manuel dikiş ve stapler yardımıyla kapatılması sık kullanılan iki tekniktir. Postoperatif pankreatik fistül oranları güdük kapama teknikleri ile ilişkili olabilir. Bu çalışma, distal pankreatektomi sonrası pankreatik fistül oranlarını belirlemek ve iki kapama yönteminin pankreas fistülü gelişimine etkisini değerlendirmek amacıyla yapıldı.

Gereç ve Yöntemler: 2011-2021 yılları arasında malign ve benign pankreas patolojileri nedeniyle elektif açık veya laparoskopik distal pankreatektomi yapılan tüm hastalar retrospektif olarak değerlendirildi. Hastalar Grup HS (manuel dikiş ile kapama) ve Grup ST (stapler yardımlı kapama) olarak gruplandırıldı. Pankreas fistülü tanısı, Uluslararası Pankreas Fistülü Çalışma Grubu kılavuzlarına göre belirlendi ve derecelendirildi. Biyokimyasal kaçak oranları ve ameliyat sonrası pankreatik fistül dereceleri birincil sonuç olarak kabul edildi.

Bulgular: Ortalama yaşı 51,8 ± 15,1 yıl olan 44 hasta (Grup HS'de 28 ve Grup ST'de 16) vardı. Gruplar demografik ve klinik özellikler açısından benzerdi (tüm p değerleri p>0,05). Grup HS'de biyokimyasal kaçağı olan 15 hasta, (%53,6) vardı. Grup ST'de altı hastanın (%37,5) biyokimyasal kaçağı olduğu tespit edildi. Gruplar arasındaki biyokimyasal kaçak gelişimi açısından anlamlı bir fark yoktu (p=0,305). Grup ST'de pankreas fistülü olan hasta yoktu. Buna karşın Grup HS'de Grade B postoperatif pankreas fistülü olan sadece bir olgu vardı. Pankreas fistülü açısından gruplar arasında anlamlı bir fark tespit edilmedi (p=0,999).

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Sonuç: Distal pankreatektomi yapılan hastalarda manuel dikiş ile kapama veya stapler ile kapama tekniklerinin biyokimyasal kaçak ve postoperatif pankreatik fistül oranları üzerinde anlamlı bir etkisi olmadığı gösterildi. Dolayısıyla, her iki pankreas güdüğü kapama yaklaşımının eşit derecede güvenli olduğu ve benzer klinik etkinlikle ile kullanılabileceği sonucuna varılmıştır.
Anahtar Kelimeler: Pankreatektomi; pankreas fistülü; dikiş; cerrahi stapler.

INTRODUCTION

Postoperative pancreatic fistula (POPF) is a challenging complication that occurs following the distal pancreatectomy. POPF is reportedly observed in up to 61% of the cases (1-3). The recent change made to the definition of POPF by the International Study Group of Pancreatic Fistula (ISGPF) is the reason for the significant variations in the incidence of POPF reported in the literature (2,4). The diagnosis and management of POPF can be problematic for clinicians and patients, particularly in the event of symptoms such as intraabdominal abscess, bleeding, sepsis, and prolonged hospitalization (1,3,5).

Several stump closure techniques are used in the context of distal pancreatectomy, including manual/hand suturing, stapler-based transection and concomitant closure of the stump, and selective suturing with stapled resection (6). The effect of these closure methods on the development of POPF has been previously investigated (1, 6-8). The hand-sewn (HS) parenchymal closure of the pancreatic stump is the conventional technique. However, given its simplicity, the stapler closure has been used more frequently during distal pancreatectomy, specifically in laparoscopic approaches (9). In 2011, the DISPACT (DIStal PAnCreaTectomy) trial, a multicenter, randomized study, showed no significant benefit of the stapler closure techniques over HS (10). Although several authors reported reduced rates of POPF as a result of using the stapler approach in the closure of the pancreatic stump, the results on the superiority of the stapler closure technique over other techniques remain controversial (1,2,8,10).On the other hand, only a limited number of studies compared the HS closure with the stapler closure of the pancreatic stump (11,12). Therefore, the search for an optimum, single surgical technique that reduces POPF rates after distal pancreatectomy continues (6,10,13).

Several pancreases - and surgery-related risk factors, including pancreatic texture, thick pancreatic stump, malignant pathology, extensive surgery, longer operation time, more significant intraoperative blood loss, and splenectomy, were all found to be associated with the development of POPF after distal pancreatectomy (6,12,14-16). Additionally, the surgical closure of the pancreatic remnant via the closure of all pancreatic branching ducts using staplers or the development of ischemia on the stump closure line due to the suturing has been reported as the primary technique-related risk factor (1,8). During HS closure, tight suturing might be a factor for ischemia and necrosis of the pancreatic stump (1). The pancreatic parenchymal closure via the stapler approach may affect the incidence of POPF due to the safe closure of all branches of the pancreatic duct. However, lack of optimal compression of the pancreatic stump may result in necrosis on the resection margin leading to POPF (17). These technical and pancreas-related variables are critical in the assessment of surgical outcomes (18).

In this context, the objective of this study is to investigate the rates of pancreatic fistula after distal pancreatectomy and evaluate the effect of HS or the stapler closure methods on this morbidity.

MATERIAL AND METHODS

Research Design

This study was designed as a retrospective study. The study protocol was approved by the local ethical committee (Haydarpasa Numune Education and Research Hospital, Ethical Committee for Clinical Studies, HNEAH-KAEK 2021/335). The study was carried out in accordance with the principles set forth in the Declaration of Helsinki. The written informed consent could not be taken from the patients due to the study's retrospective design and the data's unanimous nature.

Population and Sample

The study population consisted of all consecutive patients aged 18 years or older who underwent elective open or laparoscopic distal pancreatectomy for malignant and benign pancreatic body and tail pathologies between 2011 and 2021 in Haydarpasa Numune Education and Research Hospital. Patients with insufficient baseline or follow-up clinical data were excluded from the study. Patients were divided into two groups depending on the technique used for pancreatic stump closure: Group HS (hand-sewn closure of the stump) and Group ST (transection and closure of the stump using a stapler).

Surgical Procedure

The technical details of elective distal pancreatectomy, either open or laparoscopic, were previously described (12, 19). The same surgical team with a vast experience in open and laparoscopic pancreatic surgery performed the operations. Two different pancreatic stump closure methods were used in the hospital where this study was conducted. Accordingly, in the HS approach, the pancreatic stump was transected using a scalpel, followed by the closure of the transection line with3/0 continuous prolene sutures. On the other hand, in the stapler approach, two different staplers were used depending on the intraoperative findings and institutional facilities (Endo Echelon 60 mm stapler with a gold cartridge; Johnson & Johnson, Ethicon Endo surgery or EndoGIA; EndoGIA-II 45–4.8 stapler with a white cartridge; Tyco Healthcare, Norwalk, CT, USA) to transect and close the pancreatic stump. The decision on the closure technique to be used was left to the discretion of the attending surgeon. Consequentially, the stapler technique was chosen for all laparoscopic distal pancreatectomy operations. No additional supportive maneuvers (clipping, suturing over the stapler line, materials like mesh, or adhesive materials) were applied. Based on the intraoperative findings and malignant pathology, distal pancreatectomy was accompanied by splenectomy and lymph node dissection in cases where deemed necessary.

Follow-up Procedure

The patients were monitored for 90 days after the operation via monthly outpatient visits. Per the clinic's policy, patients' drain amylase levels were measured on

the third postoperative day. Based on any measurable volume of drain fluid on or after postoperative day 3 with amylase levels> three times more than the upper limit of normal amylase and POPF-related clinical findings, patients were categorized as the cases with biochemical leak only or with POPF graded from B to C (4). Other postoperative complications were also recorded, if any, within the scope of the study.

Variables

Patients' demographic (age, gender), clinical (body mass index, smoking history, comorbidities, the American Society of Anesthesiologists grade), laboratory ((CEA (carcinoembryonic antigen) and Ca (carbohydrate antigen)19-9 levels)), and intra- and postoperative data were obtained from their medical records available in the hospital information system. The postoperative data included the number of patients with the biochemical leak, patients with POPF and the grade of POPF, complications (intraabdominal bleeding, intraabdominal abscess), the number and type of interventions or re-operations, and pathological findings. Data about mortality were recorded on the postoperative 30^{th} and 90^{th} days. The complications were graded using the Clavien–Dindo classification system (20).

Statistical Analysis

The study's primary outcome was the development of biochemical leak and POPF with grades ranging from B to C according to the International Study Group of Pancreatic Fistula (ISGPF) guidelines (4). The postoperative 30^{th}- and 90^{th}-day mortality rates were determined as the study's secondary outcomes. Both the primary and secondary outcomes were compared between the groups.

The descriptive data were expressed as mean ± standard deviation for the continuous variables with normal distribution and median and minimum-maximum values for the continuous variables without normal distribution. Numbers with percentage values were used for categorical variables. The Shapiro-Wilk, Kolmogorov-Smirnov, and Anderson-Darling tests were used to analyze the normal distribution characteristics of the numerical variables.

The independent samples t-test was used to compare two independent groups with normally distributed numerical variables. On the other hand, the Mann-Whitney U test was used to compare two independent groups with non-normally distributed numerical variables. The Pearson's chi-squared and Fisher's exact tests were used to compare the differences between categorical variables in 2x2 tables. Additionally, the Fisher-Freeman-Halton test was used to compare the differences between categorical variables in RxC tables.

Jamovi project (Jamovi, version 2.2.5, 2022, retrieved from https://www.jamovi.org) and JASP (Jeffreys' Amazing Statistics Program, version 0.16.1, 2022, retrieved from https://jasp-stats.org) software packages were used in the statistical analysis. Probability (p) values of ≤ 0.05 were deemed to indicate statistical significance.

RESULTS

A total of 44 patients were included in the study sample. The mean age of the patients was 51.8 ± 15.1 years. Seventy-three percent of the patients were female. The demographic and clinical characteristics of the patients are given in Table 1.

The hand-sewn technique was used in 28 (63.6%) (Group HS), and the stapler technique was used in 16 (36.4%) (Group ST) patients. There was no significant difference between the groups in age, gender, body mass index (BMI) values, the American Society of the Anesthesiologists grade, and the levels of tumor markers ($p>0.05$, for all p values). There were significantly more patients with comorbidity in Group ST than in Group HS ($p=0.019$). There was no significant difference between the groups in terms of the rates of patients with hypertension (HT) and diabetes mellitus (DM) ($p=0.999$ and $p=0.464$, respectively) (Table 1).

Distal pancreatectomy via open approach was significantly more applied in Group HS than in Group ST (96.4% vs. 62.5%) ($p=0.006$). We performed concurrent splenectomy in 25 (89.3%) and 14 (87.5%) of the patients in Group HS and ST. The groups were similar considering concurrent splenectomy rate ($p=0.999$). The duration of the operation was longer in Group HS than in Group ST (220 min vs. 180 min). However, the difference between the groups was insignificant ($p=0.108$). The intraoperative bleeding was 200 ml and 135 ml in Group HS and Group ST, respectively, indicating a significant difference between the groups ($p=0.040$). Additionally, the rate of patients who were transfused intraoperatively was higher, albeit not significantly, in Group HS (25.0% vs. 6.2%, $p=0.224$) (Table 2).

The tumoral and pathological characteristics of the patients are given in Table 3. Ductal adenocarcinoma, pancreatic cystic neoplasm, and neuroendocrine tumor were the most frequent three pathologies in the groups. The comparison of the groups in terms of pathology revealed no significant difference (0.725). There was no significant difference between the groups in the diameter and differentiation grades, T, N, and TNM stages, and the harvested number of total and malignant lymph nodes ($p>0.05$, for all p values).

There were 15 (53.6%) and 6 (37.5%) patients with a biochemical leak in Group HS and Group ST, respectively. Although the rate of the biochemical leak was higher in Group HS than in Group ST, the difference between the groups was insignificant ($p=0.305$). There was only one case with Grade B POPF in Group HS ($p=0.999$). The clinical characteristics of the pancreatic fistula are given in Table 4.

A comparison of the Clavien-Dindo classification of the complications revealed no significant difference between the groups ($p=0.869$). There were 5 (17.9%) (four wound infections and one intraabdominal abscess) and 2 (12.4%) (one wound infection and one intraabdominal abscess) surgical site infections in Group HS and Group ST, respectively. There was no significant difference between the groups in the number of patients with wound infection and intraabdominal abscess ($p=0.638$ and $p=0.999$, respectively). Both 30^{th}-day and 90^{th}-day mortality rates were 3.6% in Group HS. There was no mortality in Group ST (Table 4).

Table 1. Demographic and clinical characteristics of the study groups

	Overall (n=44)	**Group HS** (n=28)	**Group ST** (n=16)	**p**
Age (year) †	51.8 ± 15.1	52.2 ± 14.9	51.1 ± 15.8	0.820**
Sex ‡				
Male	11 (25.0)	7 (25.0)	4 (25.0)	0.999*
Female	33 (75.0)	21 (75.0)	12 (75.0)	
BMI (kg/m^2) †	30.0 ± 4.9	30.0 ± 4.6	30.1 ± 5.5	0.961**
Smoking ‡				
Yes	11 (25.0)	7 (25.0)	4 (25.0)	0.999*
No	33 (75.0)	23 (75.0)	12 (75.0)	
Comorbidity ‡				
Yes	8 (18.2)	2 (7.1)	6 (37.5)	**0.019***
No	36 (81.8)	26 (82.9)	10 (62.5)	
Comorbidities				
Hypertension				
Yes	7 (87.5)	2 (100.0)	5 (83.3)	0.999*
No	1 (12.5)	0 (0.0)	1 (16.7)	
Diabetes mellitus				
Yes	6 (75.0)	1 (50.0)	5 (83.3)	0.464*
No	2 (25.0)	1 (50.0)	1 (16.9)	
ASA grade ‡				
I	20 (43.2)	15 (53.6)	5 (31.2)	0.298*
II	22 (47.7)	12 (42.9)	10 (62.5)	
III	2 (4.5)	1 (3.6)	1 (6.2)	
CEA (ng/mL) †	2.9 ± 1.5	3.2 ± 1.6	2.4 ± 1.4	0.108**
CA 19-9 (U/mL) †	28.3 ± 10.6	29.4 ± 9.4	26.4 ± 12.4	0.422**

BMI: body mass index, ASA: American Society of Anesthesiologists, CEA: carcinoembryonic antigen.
Group HS: hand-sewn closure of the stump, Group ST: (transection and closure of the stump using a stapler.
‡: n (%), †: mean ± standard deviation.
*. Pearson Chi-Square or Fisher's Exact test.
**. Independent Samples T-Test.

Table 2. Intra-operative details of the groups.

	Groups		
	Group HS (n=28)	**Group ST (n=16)**	**p**
Approach ‡			
Open	27 (96.4)	10 (62.5)	**0.006***
Laparoscopic	1 (3.6)	6 (37.5)	
Concurrent splenectomy ‡			
Yes	25 (89.3)	14 (87.5)	0.999*
No	3 (10.7)	2 (11.5)	
Operation time (min) §	220.0 [80.0 – 540.0]	180.0 [90.0 – 420.0]	0.108**
Bleeding (ml) §	200.0 [50.0 – 750.0]	135.0 [50.0 – 400.0]	**0.040****
Requirement for blood transfusion ‡			
Yes	7 (25.0)	1 (6.2)	0.224*
No	21 (75.0)	15 (93.8)	

‡: n (%), †: mean ± standard deviation, §: median [min-max]
Group HS: hand-sewn closure of the stump, Group ST: (transection and closure of the stump using a stapler.
*. Pearson Chi-Square, Fisher's Exact or Fisher Freeman Halton test.
**. Mann-Whitney U test.

Table 3. Comparison of pathological characteristics of the study groups.

	Groups		
	Group HS (n=28)	**Group ST (n=16)**	**p**
Pathology			
Ductal adenocarcinoma	8 (28.6)	5 (31.2)	
Pancreatic cystic neoplasm	9 (32.1)	4 (25.0)	
Neuroendocrine tumor	6 (21.4)	6 (37.5)	0.725*
Intraductal papillary mucinous neoplasm	3 (10.7)	1 (6.2)	
Solid pseudopapillary neoplasm	2 (7.1)	0 (0.0)	
Diameter (cm) §	4.0 [2.0 – 12.0]	4.0 [2.0 – 12.0]	0.891**
Differentiation grade (n=25) ‡			
Well	7 (50.0)	8 (72.7)	
Moderate	6 (42.9)	2 (18.2)	0.578*
Poor	1 (7.1)	1 (9.1)	
T stage (n=25) ‡			
T1	3 (21.4)	0 (0.0)	
T2	8 (57.1)	10 (90.9)	0.239*
T3	3 (21.4)	1 (9.1)	
N stage (n=25) ‡			
N0	11 (78.6)	9 (81.8)	
N1	2 (14.3)	2 (18.2)	0.999*
N2	1 (7.1)	0 (0.0)	
TNM stage (n=25) ‡			
IA	2 (14.3)	0 (0.0)	
IB	7 (50.0)	9 (81.8)	
IIA	2 (14.3)	0 (0.0)	0.412*
IIB	2 (14.3)	2 (18.2)	
III	1 (7.1)	0 (0.0)	
Total lymph node (total) §	17.0 [5.0 – 44.0]	12.0 [5.0 – 61.0]	0.121**
Malignant lymph node (malignant) §	0.0 [0.0 – 10.0]	0.0 [0.0 – 4.0]	0.849**

‡: n (%), †: mean ± standard deviation, §: median [min-max]
Group HS: hand-sewn closure of the stump, Group ST: (transection and closure of the stump using a stapler.
*. Pearson Chi-Square, Fisher's Exact or Fisher Freeman Halton test.
**. Mann-Whitney U test.

Table 4. Postoperative outcomes of the groups.

	Groups		
	Group HS (n=28)	**Group ST (n=16)**	**p**
Biochemical leak ‡	15 (53.6)	6 (37.5)	0.305*
Grade B POPF	1 (3.6)	0 (0.0)	0.999*
Drainage /day §	100.0 [30.0 – 150.0]	50.0 [20.0 – 200.0]	0.133**
POD-3 drain amylase (U/ml) §	782.0 [16.0 – 20826.0]	94.5 [10.0 – 3840.0]	0.237**
POD-3 blood amylase (U/mL) §	96.0 [65.0 – 173.0]	102.5 [66.0 – 176.0]	0.660**
Clavien-Dindo classification ‡			
0	10 (35.7)	7 (43.8)	
1	6 (21.4)	5 (31.2)	
2	9 (32.1)	3 (18.8)	0.869*
3a	1 (3.6)	1 (6.2)	
4	1 (3.6)	0 (0.0)	
5	1 (3.6)	0 (0.0)	
Surgical site infections	5 (17.9)	2 (12.4)	
Wound infection	4 (14.9)	1 (6.3)	0.638
Intraabdominal abscess	1 (3.6)	1 (6.3)	0.999
Additional interventions			
Percutaneous ‡			
Yes	1 (3.6)	1 (6.2)	-
No	27 (96.3)	15 (93.8)	
Endoscopic ‡			
Yes	0 (0)	0 (0)	-
No	28 (100.0)	16 (100.0)	
Re-do surgery ‡			
Yes	0 (0)	0 (0)	-
No	28 (100.0)	16 (100.0)	
Length of hospital stay (day) §	12.0 [5.0 – 30.0]	8.0 [5.0 – 15.0]	0.269**
30th day mortality ‡			
Ex	1 (3.6)	0 (0.0)	-
Survived	27 (96.3)	16 (100.0)	
90th day mortality ‡			
Ex	1 (3.6)	0 (0.0)	-
Survived	27 (96.3)	16 (100.0)	

‡: n (%), †: mean ± standard deviation, §: median [min-max]
Group HS: hand-sewn closure of the stump, Group ST: (transection and closure of the stump using a stapler.
POPF: postoperative pancreatic fistula, POD: postoperative day.
*. Pearson Chi-Square, Fisher's Exact or Fisher Freeman Halton test.
**. Mann-Whitney U test.

DISCUSSION

The study findings did not reveal any significant effect of using either hand-sewn or stapler closure on the biochemical leak and POPF rates in patients who underwent distal pancreatectomy. The number of patients with the biochemical leak was higher, albeit not significantly, in Group HS. There was only one type B POPF in Group HS. Based on these findings, either pancreatic stump closure approach can be used with similar clinical efficacies.

In parallel, the clinically relevant POPF and biochemical leak rates varied considerably in the literature depending only on the patient- and disease-related variables (6, 18, 21). In a study, POPF with significant clinical consequences occurred after distal pancreatectomy in approximately one-third of the patients (8, 17). Chikhladze et al. (13) reported a biochemical leak rate of 24% in a cohort of 284 patients. The total rate of patients with POPF Grade B and POPF Grade C was 37%. In comparison, Wang (21) reported 37.5% and 30% as the rate of patients with biochemical leak and POPF Grade B. Other studies reported clinically relevant POPF in as high as 42.7% of the patients (16). Kang et al. (17) investigated the rates of the biochemical leak (25% to 66.7%) and POPF (6.1% to 26.7%) according to the thickness of the pancreatic stump. In Diener's randomized, controlled multicenter trial (10), the rates of the biochemical leak, POPF Grade B and POPF Grade C, were found as 62%, 28%, and 11%, respectively. In contrast, the rates of patients with biochemical leak were found to be slightly higher (53.6% in Group HS and 37.5% in Group ST), whereas the total rate of patients with POPF Grade B and POPF Grade C was found to be lower in this study (3.6% for Group HS and 2.3% for all patients). The finding of a higher biochemical leak rate as opposed to a lower POPF rate may be attributed to using different classification systems instead of the ISGPF's system and different institutional policies in diagnosing biochemical leaks and POPF.

The texture quality of the pancreatic tissue, such as fibrotic change or fatty infiltration, the thickness of the pancreas, and the diameter of the main pancreatic duct are known as the risk factors for the development of pancreatic fistula (5, 12, 16, 17, 22, 23). However, these variables could not be addressed in this study due to its retrospective design. Increased duration of surgery (24) and blood loss (25) were found to be significantly associated with POPF in the literature. In comparison, although there was a significant difference between the groups in the amount of blood loss, there was no significant difference in the POPF rate.

Although the recent improvements in the relevant technology, including triple-row or reinforced staplers, mesh reinforcement, and titanium clips, are efficacious in reducing fistula rates, some of the randomized controlled studies and meta-analyses have not proved this finding (5-7,13, 14, 16, 26-29). In a meta-analysis and single-center trial, Tieftrunk et al. (6) reported that stapler closure, pancreatic anastomosis, or falciform/seromuscular patches lead to lower but insignificant rates of POPF than stand-alone use of suture closure. Futagawa et al. (12) pointed out the importance of the appropriateness of the cartridge of the staplers with the pancreatic consistency and thickness and recommended considering the pancreatic texture and morphometric characteristics before selecting the closure method. Using staplers to close thicker pancreatic stumps has been mentioned as a possible reason for the development of POPF (16).In comparison, standard bare staplers were used in this study to close the pancreatic stump. Illuminati et al. (18) reported that standard stapler closure caused the POPF rate to be lower than the general incidence of POPF. The rates of patients with a biochemical leak, POPF Grade B, and POPF Grade C were 41.2%, 47.1%, and 11.8%, respectively, in Illuminati's study (18). Goh et al. (30) found that reinforced staplers were superior to the bare staplers in terms of the rate of clinically significant POPF (4% vs. 26.0%). Although an uncovered manual suture closure technique has been generally believed to be the worst technique for preventing POPF (6), the findings of this study did not support this general belief. Similar findings have been reported in the ISGPS (31) expert consensus guidelines and Diener's study (10). There is a strong consensus that the POPF rates after left pancreatectomy are similar regardless of the use of open, laparoscopic, or robotic approaches or whether the hand-sewn or stapler technique is used (31). Given the heterogeneity of the studies, the direct comparisons between two simple techniques may not be sufficient to decide on the superiority of one technique over another. Moreover, current studies usually focus on combining different interventions and maneuvers. Therefore, comprehensive network meta-analyses are needed to reach more definitive conclusions (8).

There are other maneuvers used to support the pancreatic transection during pancreatic surgery. Wang et al. (2) recommended the triple combination of linear stapling, peri-firing compression, and continuous suturing in laparoscopic distal pancreatectomy. They showed that their approach effectively prevented POPF; however, their sample size was relatively small. Prolonged gradual peri-firing compression has been encouraged in the Miami guidelines (2, 9, 14, 32). Others thought that well-maintained gentle, steady traction on the suture material via continuous running suture might lead to an equal distribution of the pressure over the stump (2). Trans-pancreatic mattress suture with vicryl mesh (Woven type) in a strip 1 cm wide has been proposed as a novel technique for preventing POPF from the stumps of the pancreatic small ductal branches during open surgery (3, 5). In this technique, the authors performed the wrapment of the pancreatic stump using the strip of the mesh. In contrast, Chikladze et al. (13) found no significant difference in the rates of the biochemical leak and POPF between the uses of three different modifications, namely, the hand-sewn closure fish mouth technique, interrupted trans-pancreatic U-suture technique, and standard interrupted suture. Ratnayake's meta-analysis, which addressed the outcomes of different stump closure techniques (8), found that patch coverage after stapler or suture closure has led to the lowest POPF rate after distal pancreatectomy. In comparison, a gradual compression was used on the transection line that lasted at least 30 seconds via the closed but not fired staplers. The level of compressive pressure used on the transection line in this

approach depends on the thickness of the pancreatic stump. Accordingly, it would not be surprising to find a significant difference in the rates of POPF between different maneuvers after pancreatic surgery. Therefore, recommendations made based on observational studies should be approached cautiously.

Nowadays, pancreatic surgeries are mostly applied laparoscopically (31). Hence, given the laparoscopic resections, the stapler closure of the pancreatic stump is a technically demanding procedure. This approach can be considered the simplest yet, at the same time, the most convenient and accessible approach for closure. Additionally, different types of staplers are commonly used in laparoscopic and open pancreatic resectional surgeries (2, 3). However, favoring the use of a stapler might be regarded as a selection bias. Therefore, prospective randomized studies are needed to overcome such methodological issues.

The study's retrospective single-center design was its primary limitation. Secondly, the heterogeneity in the operative characteristics in a relatively small sample may be another limitation.

CONCLUSION

The study findings did not reveal any significant effect of using either hand-sewn or stapler closure techniques on the biochemical leak and postoperative pancreatic fistula rates in patients who underwent distal pancreatectomy. Hence, it was concluded that both pancreatic stump closure approaches are equally safe and can be used with similar clinical efficacies. Further randomized clinical trials are needed to determine the optimum method with the lowest rate of biochemical leak and clinically relevant POPF.

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REFERENCES

1. Nagakawa Y, Hijikata Y, Osakabe H, Matsudo T, Soya R, Sahara Y, et al. Why does postoperative pancreatic fistula occur after hand-sewn parenchymal closure and staple closure in distal pancreatectomy?. Surg Laparosc Endosc Percutan Tech. 2019; 29(2): e15-e19. https://doi.org/10.1097/SLE.0000000000000604.
2. Aoki T, Mansour DA, Koizumi T, Matsuda K, Kusano T, Wada Y, et al. Preventing clinically relevant pancreatic fistula with combination of linear stapling plus continuous suture of the stump in laparoscopic distal pancreatectomy. BMC Surg. 2020; 20(1): 223. https://doi.org/10.1186/s12893-020-00876-8.
3. Matsumoto I, Takeyama Y, Kamei K, Satoi S, Nakata Y, Ishikawa H, et al. Transpancreatic mattress suture with vicryl mesh around the stump during distal pancreatectomy: a novel technique for preventing postoperative pancreatic fistula. J Am Coll Surg. 2016; 223(2): e1-5. https://doi.org/10.1016/j.jamcollsurg.2016.03.027.
4. Bassi C, Marchegiani G, Dervenis C, Sarr M, Abu Hilal M, Adham M, et al. International study group on pancreatic surgery (ISGPS). The 2016 update of the international study group (ISGPS) definition and grading of postoperative pancreatic fistula: 11 years after. Surgery. 2017; 161(3): 584-91. https://doi.org/10.1016/j.surg.2016.11.014.
5. Yoshida Y, Matsumoto I, Matsumoto M, Kawaguchi K, Murase T, Kamei K, et al. Transpancreatic mattress suture with Vicryl mesh around the stump decreases postoperative pancreatic fistula after distal pancreatectomy. J Hepatobiliary Pancreat Sci. 2019; 26(11): 510-6. https://doi.org/10.1002/jhbp.664.
6. Tieftrunk E, Demir IE, Schorn S, Sargut M, Scheufele F, Calavrezos L, et al. Pancreatic stump closure techniques and pancreatic fistula formation after distal pancreatectomy: Meta-analysis and single-center experience. PLoS One. 2018; 13(6): e0197553. https://doi.org/10.1371/journal.pone.0197553.
7. Kondo N, Uemura K, Nakagawa N, Okada K, Kuroda S, Sudo T, et al. Hiroshima surgical study group of clinical oncology. a multicenter, randomized, controlled trial comparing reinforced staplers with bare staplers during distal pancreatectomy (HiSCO-07 Trial). Ann Surg Oncol. 2019; 26(5): 1519-27. https://doi.org/10.1245/s10434-019-07222-0.
8. Wang W, Qian H, Lin J, Weng Y, Zhang J, Wang J. Has the pancreatic fistula already occurred in the operation? An intraoperative predictive factor of clinical relevant-postoperative pancreatic fistula after the distal pancreatectomy. Surg Open Sci. 2019; 1(1): 38-42. https://doi.org/10.1016/j.sopen.2019.04.003.
9. Matsumoto I, Kamei K, Satoi S, Murase T, Matsumoto M, Kawaguchi K, et al. Efficacy of the slow firing method using a reinforced triple-row stapler for preventing postoperative pancreatic fistula during laparoscopic distal pancreatectomy. Surg Today. 2022; 52(2): 260-7. https://doi.org/10.1007/s00595-021-02344-z.
10. Diener MK, Seiler CM, Rossion I, Kleeff J, Glanemann M, Butturini G, et al. Efficacy of stapler versus hand-sewn closure after distal pancreatectomy (DISPACT): a randomised, controlled multicentre trial. Lancet. 2011; 377(9776): 1514-22. https://doi.org/10.1016/S0140-6736(11)60237-7.
11. Qu C, Yang YM. Manual suture or stapler closure: management of pancreatic stump during distal pancreatectomy. Zhonghua Wai Ke Za Zhi. 2020; 58(7): 494-8. https://doi.org/10.3760/cma.j.cn112139-20200410-00289.
12. Futagawa Y, Takano Y, Furukawa K, Kanehira M, Onda S, Sakamoto T, et al. Comparison of outcomes with hand-sewn versus stapler closure of pancreatic stump in distal pancreatectomy. Anticancer Res. 2017; 37(5): 2515-21. https://doi.org/10.21873/anticanres.11593.
13. Chikhladze S, Makowiec F, Küsters S, Riediger H, Sick O, Fichtner-Feigl S, Hopt UT, Wittel UA. The rate of postoperative pancreatic fistula after distal pancreatectomy is independent of the pancreatic stump closure technique - A retrospective analysis of 284 cases. Asian J Surg. 2020; 43(1): 227-33. https://doi.org/10.1016/j.asjsur.2019.03.009.

14. Pulvirenti A, Landoni L, Borin A, De Pastena M, Fontana M, Pea A, et al. Reinforced stapler versus ultrasonic dissector for pancreatic transection and stump closure for distal pancreatectomy: A propensity matched analysis. Surgery. 2019; 166(3): 271-6. https://doi.org/10.1016/j.surg.2019.02.016.
15. Miyamoto R, Sano N, Maeda M, Inagawa S, Ohkohchi N. Modified reinforced staple closure technique decreases postoperative pancreatic fistula after distal pancreatectomy. Indian J Surg Oncol. 2019; 10(4): 587-93. https://doi.org/10.1007/s13193-019-00958-x.
16. Watanabe N, Yamamoto Y, Sugiura T, Okamura Y, Ito T, Ashida R, Uesaka K. The impact of stump closure techniques on pancreatic fistula stratified by the thickness of the pancreas in distal pancreatectomy. Dig Surg. 2020; 37(4): 340-7. https://doi.org/10.1159/000505061.
17. Kang MK, Kim H, Byun Y, Han Y, Choi YJ, Kang JS, et al. Optimal stapler cartridge selection to reduce postoperative pancreatic fistula according to the pancreatic characteristics in stapler closure distal pancreatectomy. HPB (Oxford). 2021; 23(4): 633-40. https://doi.org/10.1016/j.hpb.2020.09.004.
18. Illuminati G, Cerasari S, Pasqua R, Nardi P, Fratini C, Frey S, Iannelli A, Marini P. Results of standard stapler closure of pancreatic remnant after distal spleno-pancreatectomy for adenocarcinoma. Front Surg. 2020; 7: 596580. https://doi.org/10.3389/fsurg.2020.596580.
19. Pueyo-Périz E, Téllez-Marquès C, Radosevic A, Morató O, Visa L, Ilzarbe L, et al. Radiofrequency-assisted transection of the pancreas vs stapler in distal pancreatectomy: a propensity score matched cohort analysis. Sci Rep. 2022; 12(1): 7486. https://doi.org/10.1038/s41598-022-11583-0.
20. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg. 2004; 240(2): 205-13. https://doi.org/10.1097/01.sla.0000133083.54934.ae.
21. Wang W, Qian H, Lin J, Weng Y, Zhang J, Wang J. Has the pancreatic fistula already occurred in the operation? An intraoperative predictive factor of clinical relevant-postoperative pancreatic fistula after the distal pancreatectomy. Surg Open Sci. 2019; 1(1): 38-42. https://doi.org/10.1016/j.sopen.2019.04.003.
22. Zimmitti G, La Mendola R, Manzoni A, Sega V, Malerba V, Treppiedi E, et al. Investigation of intraoperative factors associated with postoperative pancreatic fistula following laparoscopic left pancreatectomy with stapled closure: a video review-based analysis: Video-review for predictors of pancreatic leak. Surg Endosc. 2021; 35(2): 941-54. https://doi.org/10.1007/s00464-020-07912-x.
23. Ozyazici S, Erdogan O. Risk factors of postoperative clinically relevant pancreatic fistula following distal pancreatectomy with stapler closure. J Coll Physicians Surg Pak. 2021; 31(10): 1214-8. https://doi.org/10.29271/jcpsp.2021.10.1214.
24. Kawabata Y, Nishi T, Tanaka T, Yano S, Tajima Y. Distal pancreatectomy utilizing a flexible stapler closure eliminates the risk of pancreas-related factors for postoperative pancreatic fistula. Eur Surg Res. 2013; 50(2): 71-9. https://doi.org/10.1159/000349977.
25. Goh BK, Tan YM, Chung YF, Cheow PC, Ong HS, Chan WH, et al. Critical appraisal of 232 consecutive distal pancreatectomies with emphasis on risk factors, outcome, and management of the postoperative pancreatic fistula: a 21-year experience at a single institution. Arch Surg. 2008; 143(10): 956-65. https://doi.org/10.1001/archsurg.143.10.956.
26. Wennerblom J, Ateeb Z, Jönsson C, Björnsson B, Tingstedt B, Williamsson C, et al. Reinforced versus standard stapler transection on postoperative pancreatic fistula in distal pancreatectomy: multicentre randomized clinical trial. Br J Surg. 2021; 108(3): 265-70. https://doi.org/10.1093/bjs/znaa113.
27. Landoni L, De Pastena M, Fontana M, Malleo G, Esposito A, Casetti L, et al. A randomized controlled trial of stapled versus ultrasonic transection in distal pancreatectomy. Surg Endosc. 2022; 36(6): 4033-41. https://doi.org/10.1007/s00464-021-08724-3.
28. Jia B, Chen Q, Jiang P, Liu Y. An analysis of the effectiveness of stapler closure combined with a titanium clip in distal pancreatectomy. Surg Today. 2022; 1-8. https://doi.org/10.1007/s00595-022-02470-2.
29. Oweira H, Mazotta A, Mehrabi A, Reissfelder C, Rahbari N, Betzler A, et al. Using a reinforced stapler decreases the incidence of postoperative pancreatic fistula after distal pancreatectomy: a systematic review and meta-analysis. World J Surg. 2022; 46(8): 1969-79. https://doi.org/10.1007/s00268-022-06572-3.
30. Goh BKP, Lee CY, Koh YX, Teo JY, Kam JH, Cheow PC, et al. Reinforced staplers decreases the rate of postoperative pancreatic fistula compared to bare staplers after minimally invasive distal pancreatectomies. J Laparoendosc Adv Surg Tech A. 2021; 31(10): 1124-9. https://doi.org/10.1089/lap.2020.0754.
31. Miao Y, Lu Z, Yeo CJ, Vollmer CM Jr, Fernandez-Del Castillo C, Ghaneh P, et al. International Study Group of Pancreatic Surgery (ISGPS). Management of the pancreatic transection plane after left (distal) pancreatectomy: Expert consensus guidelines by the International Study Group of Pancreatic Surgery (ISGPS). Surgery. 2020; 168(1): 72-84. https://doi.org/10.1016/j.surg.2020.02.018.
32. Asbun HJ, Moekotte AL, Vissers FL, Kunzler F, Cipriani F, Alseidi A, et al. International Study Group on Minimally Invasive Pancreas Surgery (I-MIPS). The Miami International Evidence-based Guidelines on Minimally Invasive Pancreas Resection. Ann Surg. 2020; 271(1): 1-14. https://doi.org/10.1097/SLA.0000000000003590.