ABSTRACT Background: Pancreaticoduodenectomy (PD) is a complex procedure. Postoperative pancreatic fistula (POPF) is one of the most common dreaded complications of this procedure. The placement of a stent through a pancreatic anastomosis is one of the proposed surgical techniques to reduce pancreatic fistula incidence. This study aims to evaluate the utility of external stenting of pancreaticojejunostomy (PJ) anastomosis after PD in decreasing the incidence of POPF and to look for the incidence of stent-related complications.

Material and methods: This study was a prospective non-randomized observational study conducted in the Department of Surgical Gastroenterology at Sher – I-Kashmir Institute of Medical Sciences from January 2015 to January 2020. Results: A total of 72 patients were included in the study. Thirty-five were stented, and 37 had no stent. Mortality was seen in both groups (one death in each group). The morbidity rate was 32% (12/37) for the non-stent group and 35% (13/35) for the stent group (p=0.741). The overall incidence of the pancreatic fistula was 6.94% (5/72). 4 patients had grade B fistula, 3 [3/35(8.57%)] in the stent group and one [1/37(2.7%)] in the non-stent group(p=0.277). 1 patient had a grade C fistula from the stent group. The stent failed to function with no drainage of pancreatic juice in 2 patients (5.7%) and minimal flow(<50ml/24h) in 11 patients (31%). Premature stent dislodgment was detected in 8.57% (3/35). The mean time to remove pancreatic stents was 34 ± 6 postoperative days stent.

Conclusion: In conclusion, the use of external drainage of the pancreatic duct across the PJ anastomosis after pancreaticoduodenectomy does not decrease the rate of pancreatic fistula. So, the use of stents can be avoided.

KEYWORDS Pancreaticoduodenectomy, stenting, POPF

Introduction

Pancreaticoduodenectomy (PD) is a complex and technically demanding procedure. Still, over decades, it has become the procedure of choice for patients with resectable tumor of the pancreatic head, duodenum, or periampullary region. The marked advances in intensive care management, imaging technology, and interventional radiology during the last few decades and understanding of the pathophysiology of various complications have increased the safety of this surgery. In recent years, the mortality rate of pancreaticoduodenectomy has declined to <5% in many institutions worldwide [1-3]. However, postoperative pancreatic fistula (POPF) is still one of the most common dreaded complications following pancreaticoduodenectomy [1-3].
complications that occur in 5% to 40% of patients after pancreati-
coduodenectomy, depending on the definition of leak used [1-5].
Recently considerable attention has been focused on refinement
in operative techniques for PD, especially on the management
of the pancreatic remnant to decrease the incidence of POPF.
Some technical modifications such as pancreatic duct occlusion,
reinforcement of anastomosis with mesh and fibrin glue, pancre-
aticogastrostomy, octreotide, and an isolated jejunal (Roux-en-Y)
limb were introduced to improve the results in terms of reducti-
on of POPF. However, they possibly do not seem to help [6-10].

The placement of a stent through a pancreatic anastomosis
is one of the surgical techniques to reduce pancreatic fistula
incidence. Two types of stents are utilized for the procedure
viz internal and external stents. This study aimed to evaluate
the utility of external stenting of PJ anastomosis after PD in
decreasing the incidence of POPF and to look for the incidence of
stenot-related complications.

Material And Methods
This study was a prospective, non-randomized, observational
study conducted in the Department of Surgical Gastroenterol-
y at Sher-i-Kashmir Institute of Medical Sciences from January
2015 to January 2020. The study was approved and overseen
by the institutional review board. Written informed consent
was obtained from all patients. A total of 72 patients who un-
derwent PD in an elective setting were included in this study.
Exclusion criteria included patients undergoing emergency pan-
creaticoduodenectomy for trauma and patients with a history of
previous chemotherapy/radiotherapy. All relevant clinical data
details of the surgical procedure and the course after surgery
were documented prospectively using a standardized Proforma.
The documented data included patient’s age, sex, surgical pro-
cedure, use of blood products during and after surgery, duration of
the surgical procedure, details of the operation including infor-
mation on pancreatic texture and main pancreatic duct diameter,
results of the histopathological assessment of the resected speci-
men, daily analysis of drainage fluid (amount, amylase content),
time of drain removal, and duration of the hospital stay after
surgery. All operations were performed by a single surgeon ex-
perienced in pancreatic surgeries. Conventional classic Whipple
or pylorus-preserving pancreaticoduodenectomy was performed
according to the decision of the operating surgeon. The tech-
nique of PJ anastomosis was standardized. Upon completion
of the PD, the proximal 2-3 cm of the pancreatic body remnant
was mobilized in preparation for the PJ anastomosis. End to
eend PJ anastomosis using the invagination technique was done
in all patients. External drainage of the pancreatic duct using
the infant feeding tube (Romson India) was done in 35 of the 72
patients (stented group). Stenting was omitted in the remaining
37 patients (non-stented group). In other words, the patients
were not randomized. The largest-sized infant feeding tube (IFT)
that could easily pass into the pancreatic duct was used. It was
secured in place with a single 5-0 absorbable monofilament su-
ture to prevent catheter migration. The catheter exited via a
small enterotomy made in part of the loop close to the parietal
wall and was externalized through a stab incision in the anterior
abdominal wall. The enterotomy site for the exit of the catheter
was closed with a purse-string suture, and the serosa around the
enterotomy site was sutured to the parietal wall. Single-layer in-
terrupted end to side hepaticojejunostomy (HJ) was performed
using the same jejunal loop 10-15 cm away from PJ. At about
30-40 cm distal to HJ, gastrojejunostomy (GJ) or duodenoojejun-
tomy (DJ) was performed. Feeding jejunostomy (FJ) was not
a routine. The surgical drain was placed near the site of the
pancreateojejunostomy as routine in all cases covering all three
anastomoses and connected to a closed drainage system to de-
tect and drain potential leaks. The pancreatic duct tube (external
stent) was connected to a drainage bag system. Both the vol-
ume and amylase content of drain fluids were recorded daily.
All patients were observed in the postoperative period till dis-
charge and followed up in the outpatient department clinic for
30 days at regular intervals for this study. Development of sur-
gical site infection, intra-abdominal collection/abscess, biliary
leak, pancreatitis or sepsis syndrome were recorded and docu-
mented. Postoperative pancreatic fistula (POPF) was defined
and graded as per the international study group for pancreatic
fistula (ISGPF) and recorded. Delayed gastric emptying (DGE) and post-pancreatectomy haemorrhage (PPH) defined
and graded as per the international study group of pancreatic
surgery was also recorded in predesigned proforma. Periopera-
tive management was standardized and strict protocols of our
high-volume PD unit were followed. All patients received broad-
spectrum antibiotics postoperatively. Prophylaxis for stress ul-
ercation was also given in all patients. Pharmacological prophyl-
axis for thromboembolism was used selectively. The nasogastric
tube was removed immediately after surgery or the following
day. Epideral analgesia was given until 72 hours postoperatively.
Parenteral nutrition was not routinely used. Octreotide was
not used. An oral diet was typically started on postoperative
day 3 or with the first sign of bowel activity. Orals were with-
held as per need in patients with evidence of delayed gastric
emptying, pancreatic leakage or other intra-abdominal compli-
cations. Drains were removed when there was no evidence of
leakage. If there was evidence of leakage or suspicion of infec-
tive complication (fever, leucocytosis and purulent drain fluid
discharge), the peripancreatic drains were left in situ, and an
abdomen ultrasound was done to look for any intra-abdominal
collection. Contrastenhanced computed tomography (CECT)
scan was performed selectively, and intervention was done, if
required. All patients had bile cultured intraoperatively, and if
needed, culture-specific antibiotics were used as per indication.
The external stent was left connected to the drainage bag during
the first 10 days and daily output was measured. If there was
no evidence of pancreatic fistula, the catheter was locked. The
patients were discharged with the stent in situ until 8 weeks after
the operation and then removed in the outpatient clinic. If there
was a pancreatic leak, stent was allowed to drain pancreatic juice
until the leakage resolved. The primary endpoint of the study
was the development of pancreatic fistula or leakage, defined
as per ISGPF definition of a drain output of any measurable
volume of fluid on or after, postoperative day 3 with amylase
greater than three times the serum amylase activity. Secondary
endpoints included overall morbidity rate, total postoperative
hospital stay and hospital mortality rate.

Statistical Analysis
Continuous data were expressed as mean±SD. Patient demo-
graphics and clinical characteristics were compared using the
Chi-square test or Fisher’s exact test for categorical variables,
and student’s t-test and Mann-Whitney test for continuous vari-
ables. A P-value of less than 0.05 was considered statistically
significant. The statistical analysis was carried out using, Sta-
tistical Package for Social Sciences (SPSS Inc., Chicago, IL, USA
version 15.0 for windows).
Results

The current study examined the relevance of stenting of PJ in reducing the POPF rate and morbidity after PD. A total of 72 patients who successfully underwent elective pancreaticoduodenectomy were included in the study. Thirty-five were stented, and 37 had no stent. There were no significant differences in patient demographics, past medical history, the presence of comorbid illness, diagnosis of preoperative symptoms, or preoperative procedures. Two groups were comparable in the proportion of conventional and pylorus-preserving pancreaticoduodenectomy, operation duration, operative blood loss, transfusion requirement, and hospital stay duration (Table 1). Specific pathologic diagnosis were also comparable between the two groups. The median diameter of the main pancreatic duct was 4.3mm (range 1.2-12.4), and the median diameter of the bile duct was 8.8mm (range 3.2-33.9 mm).

The overall rate of complications, the types and grades of complication classification, mean duration of intra-abdominal drainage and, postoperative intensive care unit rates were all comparable between the two groups (Table 2).

There were 2 deaths. One in the stent group due to Grade C POPF complicated by multi-organ failure, one in the non-stent group due to hospital-acquired pneumonia complicated by respiratory failure. The overall 30-day mortality rate was 2.78% (2/72). The morbidity rate was 32% (12/37) for the non-stent group and 35% (13/35) for the stent group, and the overall morbidity rate was 34.72% (25/72). The proportion of patients with severe complications (Clavien Dindo grades 3-5) were 11.42% (4/35) in the stent and 5.40% (2/37) in the no-stent groups.

The overall incidence of the pancreatic fistula was 6.94% (5/72). 4 patients had grade B fistula, 3 (3/35(8.57%)) in the stent group and one [1/37(2.7%)] in the non-stent group. These fistulas either resolved spontaneously or were treated successfully. The incidence of pancreatic fistula when the pancreatic duct diameter was less than or equal to 2.0mm and 2.1 to 4.9mm was 10.7% (3/28) and 5.88% (2/34), respectively. No pancreatic fistula was seen in patients with pancreatic ducts 5.0mm wide. Patients with pancreatic leakage had late resumption of oral intake, longer postoperative hospital stays, and later removal of the pancreatic stents and the abdominal drain. Acute pancreatitis was recognized in 3 patients. 2 in-stent group 5.72(2/35) and 1 in non-stent group 2.7% (1/37). Delayed gastric emptying was observed in 5.56% (4/72) patients, 2 in each group. Biliary anastomotic leakage occurred in 1 patient in the stent group that closed spontaneously. Intra-abdominal haemorrhage was seen in 2 patients, 1 in each group. One sentinel bleed in the non-stent group (managed conservatively) and another bleed in the stented group was controlled by interventional radiologically guided arterial embolization. 5 patients developed intra-abdominal collection, (IAC) 3 in stented group [3/35(8.57%)] and 2 in non-stent group [2/37 (5.4%)]. 2 resolved after aspiration, 2 had a PCD, and 1 collection was small < 3cm that was managed successfully with observation. The stent failed to function with no drainage of pancreatic juice in 2 patients (5.7%) and minimal flow(<50ml/24h) in 11 patients (31%). Premature stent dislodgment was detected in 8.57% (3/35). The mean length of postoperative hospital stay was also similar in both groups. The mean time to remove pancreatic stents was 34 ± 6 postoperative days. None of the patients experienced peritonitis localized or otherwise after removing the external stent tube.

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Discussion

Pancreatic fistula affects between 5% to 40% of patients following PD. It is associated with a significantly more complicated postoperative course with the development of IAC, intra-abdominal abscess formation, PPH, organ failure, prolonged ICU stay and mortality [12]. Therefore it is essential to implement strategies to reduce the rate of POPF following PD. Stenting of the pancreatic duct is one of the methods proposed to decrease the incidence of POPF following PD. The causes are multiple for placing a stent, and there are reasons why it is very convenient to check the volume, colour and characteristics of the drainage fluid of pancreatic juice [17]. Another superiority of placing stents externally is avoidance of stent migration observed with internal stents [5].

There is a considerable debate in the literature on the utility of external stents in reducing POPF. Some authors have even warned of the potential dangers associated with using a stent. Stent-related complications include transient peritonitis, stent obstruction, kinking and pancreatitis [18].

Matsumoto et al. reported a 16% pancreatic fistula rate using stent [19]. Hamanaka et al. reported a 4% fistula rate [20], and Howard reported zero pancreatic fistulas in 56 consecutive cases [21]. All of these series lacked a control group without pancreatic duct stents. Roder et al. reported a 7% pancreatic fistula rate in patients with stented external drainage of the pancreatic duct compared to a 29% fistula rate in patients without a pancreatic duct stent (P=0.007) [16]. Motoi suggested that the benefits of pancreatic stent stenting are more pronounced with external stents than internal [22]. Poon et al. showed that an external stent decreased the POPF rate from 20 to 6.7% [5]. Pessaux et al. [23] specifically evaluated the use of pancreatic stents in the setting of soft pancreatic texture and a non-dilated pancreatic duct (<3mm). This high-risk cohort showed a significant reduction in POPF associated with external drainage of the pancreatic duct stent (stent) vs 42% (non-stent); P=0.034.

Contrary to these results, Winter et al. have demonstrated that a non stented PJ had the same outcome as a stented PJ after PD [24]. No benefits were observed for pancreatic duct stenting. A trend was observed towards increased pancreatic fistulas in patients with soft pancreatic remnants and stents compared to those with soft pancreatic remnants and no stents in a randomized multicentric trial comparing external and internal pancreatic stenting during PD. Jang et al. observed that external stenting was associated with a higher clinically relevant POPF than internal stenting [25]. Kuroki et al., in their study, consid-
### Table 1 Baseline characteristics of the patients

|                     | STENT      | NO STENT    | P-VALUE |
|---------------------|------------|-------------|---------|
| Age (Mean ± SEM)    | 59 ± 11    | 57 ± 12     | 0.463   |
| Sex (Male/Female)   | 22/13      | 22/15       | 0.0768  |
| Presence of comorbid illness | 10         | 11          | 0.914   |
| Preoperative biliary drainage (Yes/No) | 16/35     | 17/37       | 0.984   |

### Table 2 Intraoperative data and pathological diagnosis

|                     | STENT      | NO STENT    | P-VALUE |
|---------------------|------------|-------------|---------|
| Texture of pancreas |            |             |         |
| Soft                | 28         | 29          | 0.866   |
| Hard                | 07         | 08          | 0.866   |
| Mean operation time (minutes) | 320 ± 67    | 307 ± 59     | 0.386   |
| Average intraoperative blood loss (ml) | 225 ± 84    | 216 ± 92     | 0.66    |
| Disorder (no.)      |            |             |         |
| Carcinoma of head of pancreas | 17         | 15          | 0.493   |
| Ampullary/duodenal tumor | 11         | 12          | 0.927   |
| Carcinoma of bile duct | 06         | 08          | 0.631   |
| Chronic pancreatitis | 01         | 02          | 0.589   |
| Pancreaticoduodenectomy |            |             |         |
| Standard             | 01         | 01          | 0.99    |
| Pylorus preserving   | 34         | 36          | 0.99    |
| Diameter of pancreatic duct (mm) | 13         | 15          | 0.768   |
| ≤ 2.0               | 13         | 15          | 0.768   |
| 2.1 – 4.9           | 16         | 18          | 0.803   |
| ≥ 5.0               | 06         | 04          | 0.437   |
| Mean hospital stay ± SEM (days) | 18 ± 7     | 16 ± 9       | 0.295   |

### Table 3 Post-operative mortality and morbidity

|                     | STENT      | NO STENT    | P-VALUE |
|---------------------|------------|-------------|---------|
| Mortality           | 01         | 01          | 0.99    |
| Overall morbidity   | 13         | 12          | 0.741   |
| DGE                 | 02         | 02          | 0.959   |
| POPF                | 04         | 01          | 0.145   |
| Grade B             | 03         | 01          | 0.277   |
| Grade C             | 01         | 00          | 0.99    |
| Bile leak           | 01         | 00          | 0.99    |
| Hemorrhage          | 01         | 01          | 0.00    |
| Wound infection     | 04         | 03          | 0.635   |
| Intra – abdominal collection | 03         | 02          | 0.597   |
| Respiratory complications | 03         | 03          | 0.943   |
| Sepsis              | 04         | 03          | 0.635   |
We recommend to avoid external stenting of the PJ anastomosis after pancreaticoduodenectomy does not appear to reduce the rate of pancreatic fistula. However, surgeons have to understand that several important factors are involved in pancreaticoenteric anastomotic healing and resultant anastomotic complications. Some of these confounding factors are surgical technique, appropriate apposition of tissues and placement of sutures, surgical experience, nutritional status, pancreatic texture, and diameter of main pancreatic duct. Also, in the era of ERAS, avoidance of pancreatic stents in PD may be a justified option.

In this prospective comparative study, we found that the external stenting of the pancreaticojejunostomy anastomosis does not appear to reduce the rate of pancreatic fistula. The limitation of this study is that it is a non-randomised study with a limited small number of patients. However, even then, all the cases were operated by a single experienced surgeon, thus ensuring the uniformity of the surgical technique and eliminating surgeon-related and surgical technique-related bias in the study.

Conclusion
In conclusion, the use of external drainage of the pancreatic duct across the PJ anastomosis after pancreaticoduodenectomy does not decrease the rate of pancreatic fistula. Though not statistically significant, all complications were less frequent in the non-stented group. Based upon the observations from our study, we recommend to avoid external stenting of the PJ anastomosis after PD, however we would like other large sampled, randomised studies be done to further clarify this debated subject.

Author contribution
Prof Sadaf Ali and Dr Mohd Riyaz developed the study concept and design. Acquisition and interpretation of the data was done by Dr Prince Ajaz.

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