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ORIGINAL ARTICLE

Outcome of 150 Consecutive Blumgart's Pancreaticojejunostomy After Pancreaticoduodenectomy

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Abstract

Postoperative pancreatic fistula (POPF) is the most feared complication after pancreaticoduodenectomy (PD) that leads to intra-abdominal abscess, sepsis, or bleeding and remains the single most important source of morbidity and mortality after PD. To minimize this dreaded complication, various surgical techniques and modifications of pancreaticoenteric reconstruction have been proposed. However, still POPF does occur even in experienced hands. We herein describe the outcome of 150 post PD patients who underwent duct-to-mucosa (DM) pancreaticojejunostomy (PJ) using a special technique, Blumgart's "through & through" U transpancreatic sutures. The technique is described in detail. Postoperative octreotide and metoclopramide were used in all patients for 3 days. An enhanced recovery (ERAS) protocol was followed in a subset of patients. All patients were ASA grade 1 and had adenocarcinoma of the periampullary region/pancreatic head and underwent standard pylorus resecting PD after due optimization. Eighty-eight (58.7%) patients had pancreatic duct $\leq$ 3 mm and pancreatic texture was soft to very soft in 112 (74.6%) patients. There was only one International Study Group of Pancreatic Surgery (ISGPS) grade C POPF with concomitant hemorrhage. Five patients developed ISGPS grade B and two grade C, delayed gastric emptying (DGE). There was no 30-day mortality. The average length of hospital stay was 7.3 ± 4.2 days with a median of 6 days in the ERAS subset of patients. Blumgart's "through & through" DMPJ technique is very helpful in reducing the POPF and other complications even in high-risk pancreas (i.e., soft with a small pancreatic duct) and is easy to learn and perform.

Keywords Pancreaticojejunostomy · Pancreatic fistula · Post pancreatectomy hemorrhage · Delayed gastric emptying · Enhanced recovery protocol · Pancreatic cancer · Periampullary cancer · Pancreaticoduodenectomy

Introduction

Pancreaticoduodenectomy (PD) is a major surgical procedure that entails removal of the head of the pancreas, duodenum, and proximal jejunum with distal stomach (Whipple's) or with/without pylorus (pylorus resecting/pylorus preserving) along with regional lymph nodes and at times concomitant complex vascular resection ± other organs directly involved by the tumor. Management of the pancreatic stump is a major task during the reconstructive phase of PD. The Achilles heel of the reconstruction post PD is anastomosis of the pancreatic remnant either with the jejunum (pancreaticojejunostomy PJ) or with the stomach (pancreaticogastrostomy PG). It is so because it is often the site of complications which at times can be life threatening, viz., postoperative pancreatic fistula (POPF).

Literature is flooded with techniques of performing PJ/PG ever since 1940, when Hunt described PJ to avoid leakage of the pancreatic stump [1]. Refinements in the PJ followed and an early detailed procedure was outlined by Child in 1944 [2], and now we have over 70 modifications of this technique [3].

We herein report our results of 150 consecutive PD using Blumgart's through-and-through suturing technique and describe the technique in detail.

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Patients and Methods

One hundred fifty diagnosed patients of pancreatic head or periampullary cancer who underwent PD were included in this study. An informed consent was obtained from each patient. A detailed history, examination, and tumor findings were recorded. Staging was done by a pancreatic protocol triple-phase contrast-enhanced computed tomography (CECT) scan.

All patients had histopathogically proven adenocarcinoma. A pylorus resecting PD (PRPD) was performed in each case. All patients were optimized before surgery and were ASA grade I. A standardized enhanced recovery after surgery (ERAS) protocol was followed in the last 50 subset of patients.

Blumgart's PJ Technique

Leslie H. Blumgart from Memorial Sloan Kettering Cancer Center (MSKCC), New York [4], described a novel technique of "duct-to-mucosa PJ" (DMPJ) using transpancreatic U "through & through" sutures. It is an excellent technique whereby there are no tangential tension and shear forces on the PJ site and it is especially beneficial in soft pancreas often present in periampullary cancer [4, 5]. As described in detail below, with this technique, it is possible to cover the pancreatic cut end completely with the jejunal serosa. This technique performed over the last 25 years at MSKCC has been clinically tested and has yielded favorable results in the parent institution and across the world [6].

1. Preparation of the Pancreatic Stump

After removal of the specimen and securing hemostasis, the pancreatic stump is mobilized for about 1–2 cm off its bed and splenic vein using the two stay sutures at either end of the cut or end of the pancreas lifting the gland up. We always divide the pancreas at the neck between stay sutures at either end which helps in stabilizing the gland and also secures hemostasis.

2. Preparation of the Jejunal Loop

The jejunal loop is brought in the upper abdomen through an opening in the transverse mesocolon right of the middle colic vessels. The stapled end of the jejunum is oversewn with interrupted silk 2/0 stitches.

3. Placement of Transpancreatic U "Through & Through" Sutures

A small nasogastric tube is placed in the pancreatic duct as a temporary stent. This ensures that the duct is not included accidentally in the transpancreatic sutures. The fist suture is taken with PDS 3/0 22-mm needle. The needle is carefully passed from the anterior surface of the pancreatic stump approximately 0.5 cm from the cut surface taking care to avoid the pancreaticoduodenal vessels. The needle is brought out from the posterior surface of the pancreatic stump. The needle is then used to take a good seromuscular horizontal bite in the jejunum of approximately 1 cm close to the mesentery. In the next step, the same needle is passed from the posterior to the anterior surface of the pancreas coming out about 0.5 cm away from the entry site (Fig. 1).

Like this, about six such transpancreatic stitches are taken, three cranial and three caudal, to the pancreatic duct and held serially in hemostats without tying any knots and maintaining distance between the pancreas and the jejunum as shown in the figure. Thus, the posterior row of stitches is completed.

4. Placement of "Duct-to-Mucosa" Stitches

We use PDS 4/0 13-mm needle sutures for DMPJ. A small opening is made in the jejunum directly opposite to the pancreatic duct using needle tip cautery. Corner stitches are fist placed at 12 o'clock and 6 o'clock positions (Fig. 2). The PDS 4/0 suture is passed from outside the jejunum in to the jejunal opening and then from inside the pancreatic duct in to the pancreatic stump taking a good bite of the pancreatic parenchyma. The posterior stitch is next placed with the needle moving in through the pancreatic duct in to the jejunal opening. Similarly, the anterior stitch is placed moving from the jejunum (outside in) to pancreatic duct (inside out). If the duct is dilated, more posterior and anterior stiches are placed in a similar fashion. Again, no knots are tied, and the cut ends of the sutures are held in hemostats. The temporary pancreatic duct stent helps in placement of ductal stitches.

5. Tying the Knots

The transpancreatic U stiches placed before are now tied serially approximating the pancreatic stump to the jejunum. The needles are still held and not cut. Next, the temporary pancreatic duct stent is removed and duct-to-mucosa stitches are held tight approximating the pancreatic duct to jejunal mucosa. These DM sutures are then tied. This ensures no tension on the DM stiches as the pancreatic stump is nicely placed over the jejunum and secured in place.

6. Placement of Anterior Layer Stitches

The first corner suture is taken a little differently. One seromuscular bite is taken close to the mesentery of the jejunum perpendicular to the longitudinal axis of the jejunum, and again another seromuscular bite is taken horizontally in such a way that the corner of the pancreatic stump gets wrapped up nicely in the jejunum (Fig. 3).

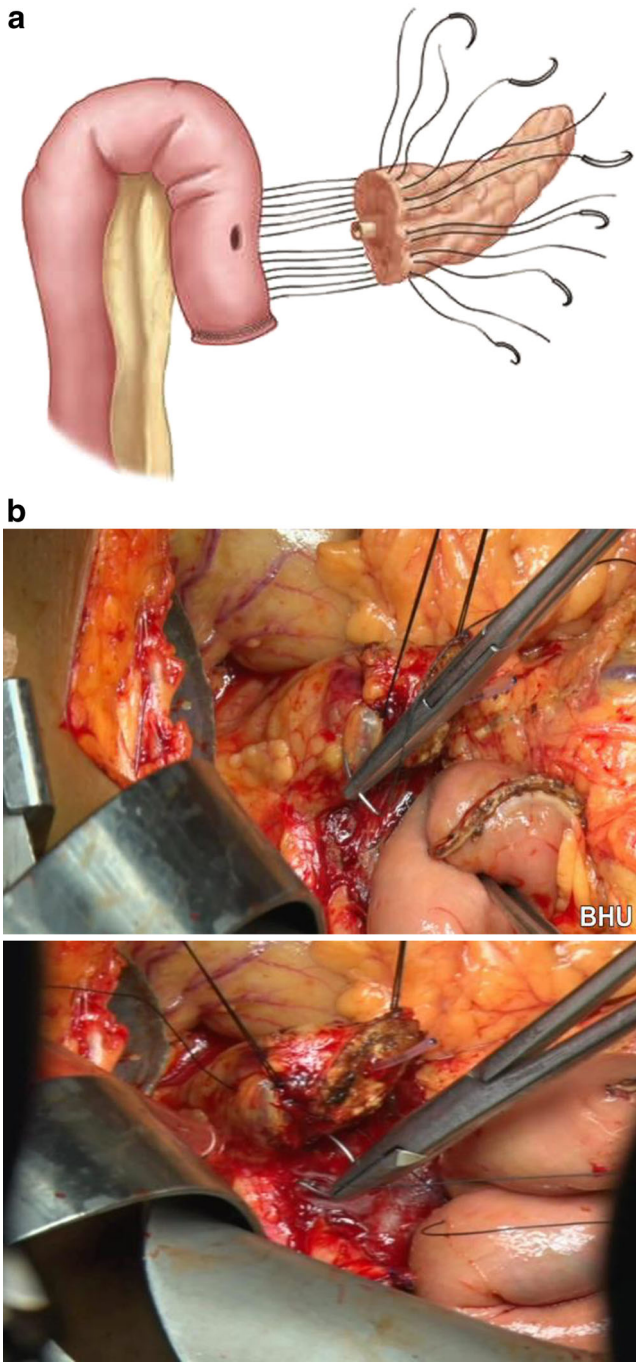

Fig. 1 Placement of transpancreatic "through and through" U sutures. a Diagrammatic representation (taken from reference [6]: produced with permission), **b** Operative photographs

The other four stitches are taken sequentially as horizontal seromuscular bites in the jejunum. The last corner stich is again taken as described above with two seromuscular bites in the jejunum. All the six stiches are held in line and tied one after the other. Upon completion of the anastomosis, the jejunum can be seen completely wrapped around the pancreatic stump without any tangential shear force (Fig. 4).

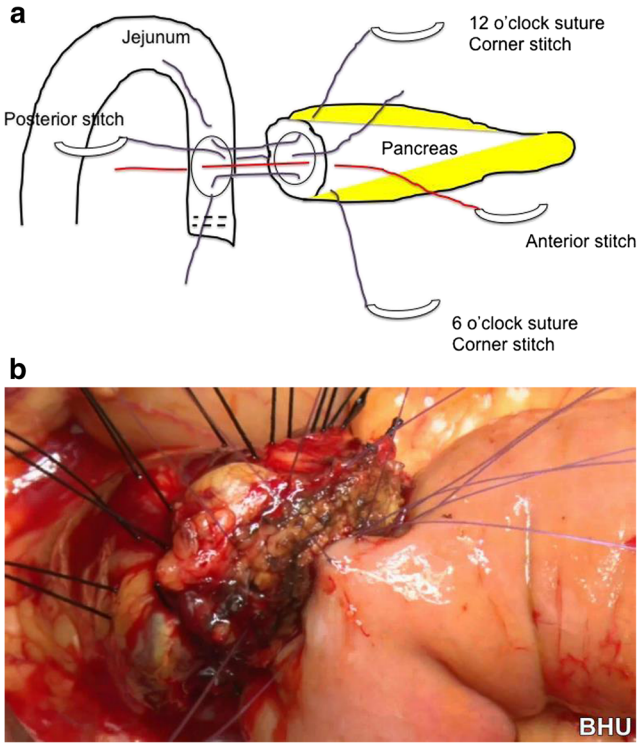

Fig. 2 Placement of Duct-to-mucosa stitches. a Diagrammatic representation **b** Operative photograph

Results

All 150 PD were performed by a single experienced surgeon in the Hepatopancreatobiliary and Gastrointestinal Oncology Division, Department of Surgical Oncology, of a tertiary care hospital. The histopathology result was adenocarcinoma in all cases. The mean age of patients in our study was 51.2 $\pm$ 10 years ranging from 28 to 75 years. Preoperative biliary stenting was done in 60% of patients. Few were for cholangitis and/or delay in surgery for more than 2 weeks, but many patients were referred to us already with a biliary stent in situ. The ampulla of Vater was the most common location of tumor in this study comprising 72% of cases. The pancreatic texture was soft to very soft in 112 (74.6%) patients and firm to hard in the rest. The operative time ranged from 200 to 300 min and average blood loss was 220 mL. The pancreatic duct size was grouped under two categories: $\leq$ 3 mm or > 3 mm. Only 62 (41.3%) patients had pancreatic duct >3 mm. Only one patient developed grade C POPF as per the International Study Group of Pancreatic Surgery (ISGPS) guidelines. He also developed postpancreatectomy hemorrhage. Five patients had grade B and two had grade C, delayed gastric emptying (DGE). There was no postoperative 30-day mortality. We standardized our ERAS protocol and conducted a study in a subset of 50 patients which is a part of a separate publication. The average length of hospital stay was 7.3 $\pm$ 4.2 days with a median of 6 days in the ERAS group.

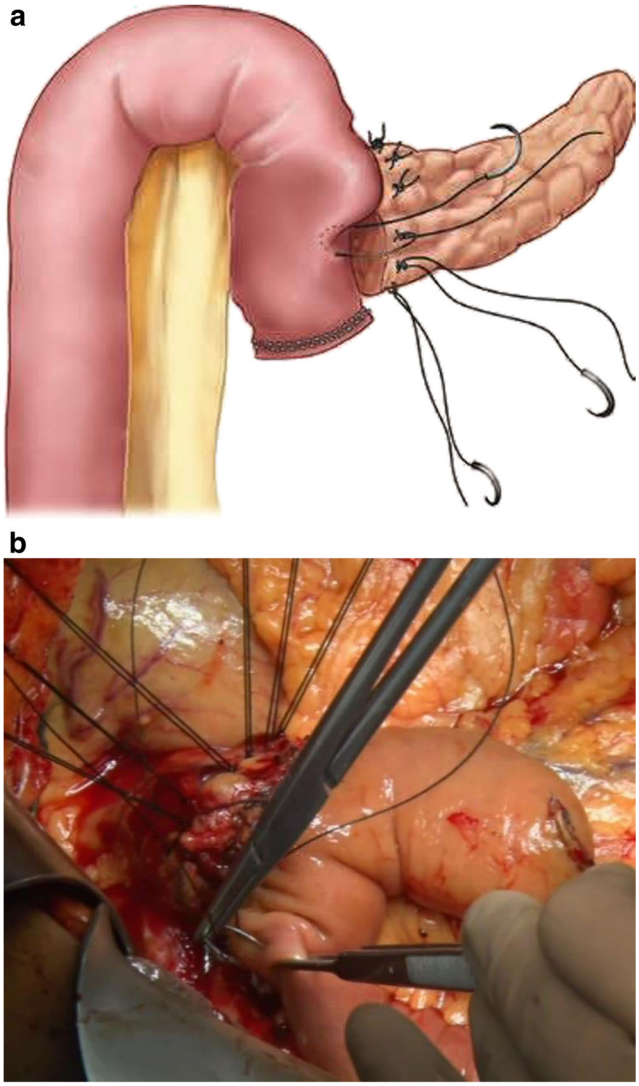

Fig. 3 Placement of anterior layer of stitches. a Diagrammatic representation(taken from reference [6]: produced with permission), **b** Operative photograph

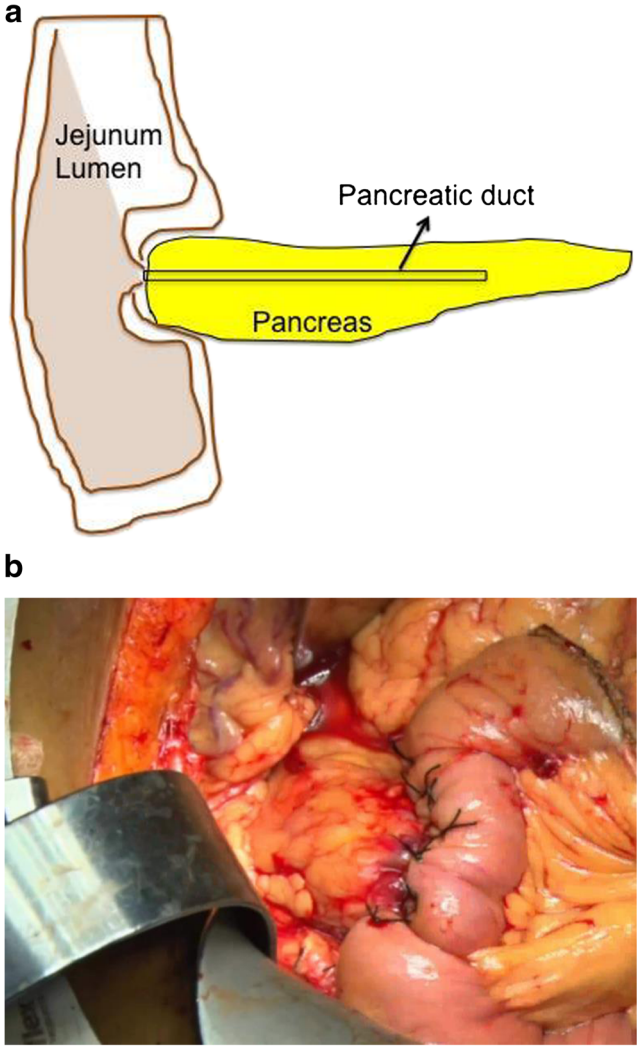

Fig. 4 Upon completion of Pancreaticojejunostomy, the jejunum is completely wrapped around the pancreatic stump. a Diagrammatic representation **b** Operative photograph

Discussion

Although mortality after PD has decreased to less than 5% in high-volume centers, morbidity still remains close to 40%. POPF remains the most dreaded complication of PD, and the rate remains higher than 10% in most prospective studies [7–10]. POPF is a harbinger of other linked complications like DGE, longer hospital stays, readmissions, increased treatment costs, delay in adjuvant treatment, and at times postoperative mortality and reduced overall survival [11].

There are several patient (age, obesity, comorbidities like diabetes mellitus or cardiovascular disease, pancreatic texture [soft/firm/hard], and pancreatic duct size)-, disease (benign or malignant etiology)-, and surgery (type of technique used, surgeon/hospital volume, use of perioperative somatostatin analogues, stents, glue, etc.)-related factors that have been analyzed to contribute to the POPF. A soft pancreas and small pancreatic duct are high risk for development of POPF even in most experienced high-volume surgeons.

Detailed and exhaustive data analysis of various variables revealed four distinct factors often associated with POPF, viz., pancreatic duct size smaller than 3 mm and ampullary, duodenal, cystic, or islet cell pathology (clinically relevant POPF nearly 3 times as likely); soft pancreatic parenchyma (POPF 5-fold increase); and intraoperative blood loss in excess of 1000 mL (POPF 6-fold increase). This study formed the basis of the Fistula Risk Score, which helps predict the likelihood of POPF [11].

Periampullary tumors are often characterized by a soft pancreatic texture and small pancreatic duct. Thus, most of our patients were in high-risk group. A pancreaticoenteric anastomosis is especially difficult in a soft pancreas. There are several reasons to it. Firstly, a soft pancreas is friable; there is danger of tearing as sutures are placed, and it is overall more susceptible to ischemia and injury. Secondly, the pancreatic

duct is often not dilated and is small; it is not only more challenging to reconstruct but also more likely to either occlude or dehisce. Lastly, a soft pancreas is an active gland and hence susceptible to leakage and inflammation.

Literature is full of various techniques of PJ and PG. Some recent trials show PG to be superior to PJ in terms of POPF rates but with increased risk of postpancreatectomy hemorrhage. However, of late large meta-analysis failed to confirm the superiority of PG versus PJ, and the debate continues [12–18]. There remains a significant heterogeneity and bias among these studies vis-a-viz standardized definition of POPF and other complications, no technique standardization, multicenter multiple surgeons, no attempt at internal quality control, different time frames, no stratification of soft/firm or hard pancreatic texture, pancreatic duct diameter, histology, use of octreotide and pancreatic duct stents or glue/mesh, etc. ISGPS has done commendable work in bringing up standard definitions on various aspects of pancreatic surgery and its complications [15, 18–23], but there still is not enough data that can be complied and interpreted uniformly and globally. Thus, it seems difficult if ever a conclusion could be drawn to one technique being the "best."

It is important to understand that the four most important factors in construction of a PJ include a tension-free anastomosis, good vascularity, no laceration of the pancreatic parenchyma, and good approximation of the pancreas and jejunum. Excellent results have been reported for Blumgart's technique which helps to achieve all the four above.

Kleespies A et al. [24] reported significantly lower operating time, blood loss, POPF (4%), postoperative hemorrhage, overall complications, and length of ICU stay with Blumgart's anastomosis. Another study by Grobmyer SR [5] also found markedly reduced clinically significant pancreatic anastomotic failure (ISGPF grade B or C) of only 6.9%. In addition, there was no bleeding, reoperation, or mortality secondary to pancreatic anastomotic failure among patients in their series. Mishra et al. from India conducted a retrospective study and reported an ISGPS grade B ($n = 4$) and grade C ($n = 3$) POPF in seven (7.14%) patients with one patient requiring relaparotomy due to leak. Only one patient died due to a leak-related complication [25].

A Japanese study [26] compared the Katika method and modified Blumgart's method of PJ with 120 patients in each group. Clinically relevant POPF formation was significantly lower in the Blumgart's group versus the Kakita group (2.5 vs 36%; $p < 0.001$). Multivariate analysis showed Blumgart's technique to be an independent predictor of non-formation of POPF (hazard ratio, 0.02; 95% confidence interval, 0.01–0.08; $p < 0.001$). Another study from Japan comparing the above two PJ techniques reported the rate of ISGPF grade B and C POPF of 29/78 (37.2%) in the Kakita group and 16/78 (20.5%) in Blumgart's group ($p = 0.033$). The median hospital stay for the Kakita group was 23 days, whereas that for the Blumgart group was 16 days ($p < 0.001$), one of the shortest value among Japanese high-volume centers [27]. A study from Taiwan revealed significantly lower clinically relevant POPF in Blumgart's PJ group compared to PG for overall patients (7% vs 20%, $p = 0.007$). There was no surgical mortality in Blumgart's PJ group, but a 4.9% perioperative mortality in the PG, $p = 0.030$ [28].

A study even reported successful application of Blumgart's PJ technique during laparoscopic PD [29]. Encouraged by these results, Blumgart's PJ is now subject to further assessment in randomized trials. One such trial, PANasta trial, is already recruiting patients, and the results are likely to be published early next year. It is a randomized, double-blinded multi-center study, whose primary aim is to assess whether a Blumgart pancreatic anastomosis (trial intervention) is superior to a Cattell-Warren pancreatic anastomosis (control intervention) in terms of pancreatic fistula rates [30]. Another trial from Japan randomized patients to either interrupted suture (103 patients) or modified Blumgart mattress suture (107 patients) groups. The results which have been recently published revealed that grade B/C POPF occurred in seven patients (6.8%) in the interrupted suture group and 11 (10.3%) in the mattress suture group ($p = 0.367$) [31].

ERAS pathways are multimodal, evidence-based proactive approaches to optimize patient outcome after surgery and include preoperative optimization, aggressive pain control, early ambulation, early initiation of oral diet, and thromboprophylaxis among others. ERAS was first started for elective colorectal surgery [32] and has now become the standard of perioperative care in most centers [33]. Its acceptance and application after PD however remain slow owing to dreaded complications associated with PD. There is evidence in literature to support its application after PD [34]. Encouraged by our remarkable improved results following Blumgart's DMPJ, we developed ERAS protocol on guidelines by the ERAS society published in 2012 [35]. Our results in a subset of last 50 patients have been very promising and are a subject of a separate publication.

Conclusion

While no technique can guarantee 0 POPF rate nor can be labeled as "the ideal" or "the best," Blumgart's PJ technique is certainly one of the best techniques that is easy to learn with lowest POPF and other complication rates post PD. It reduced our POPF rate and also enabled ERAS protocol to be implemented in our patients with success.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

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