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ORIGINAL ARTICLE

Is systematic nasogastric decompression after pancreaticoduodenectomy really necessary?

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Abstract

Background Since the spread of enhanced recovery programs, early withdrawal of the nasogastric tube (NGT) is recommended after pancreaticoduodenectomy (PD), although few data on the safety of this practice are available. The aim of the present study was to evaluate the absence of nasogastric decompression after PD on postoperative outcome.

Study design All consecutive patients undergoing PD between January 2014 and December 2015 at a single center were retrospectively analyzed. Since May 2015, all operated patients had the NGT removed immediately after the procedure (NGT − group) and were compared to patients operated before this practice (NGT+ group), who had the NGT maintained until at least postoperative day 3.

Results During the study period, 139 patients underwent PD, of whom 40 (29%) were in the NGT− group and 99 (71%) were in the NGT+ group. The length of hospital stay (LOS) and rate of postoperative complications of grade 2 or higher according to the Clavien-Dindo grading system were significantly higher in the NGT+ group [14 (11–25) vs. 10 (8–14.2), $P = 0.005$ and 82.8 vs. 40%, $P < 0.001$, respectively]. Incidence and severity of delayed gastric emptying (DGE) grade B–C were also higher in the NGT + group (45.5 vs. 7.5%, $P < 0.001$). There was no difference between the two groups concerning the 90-day postoperative mortality ($P = 0.18$).

Conclusion The absence of systematic nasogastric decompression after PD might reduce postoperative complications, DGE, and LOS. These encouraging results deserve to be confirmed by a prospective randomized study (NCT: 02594956).

Keywords Pancreaticoduodenectomy · Nasogastric tube · Enhanced recovery · Delayed gastric emptying

Abbreviations

NGT	Nasogastric tube
PD	Pancreaticoduodenectomy
LOS	Length of hospital stay
DGE	Delayed gastric emptying
ERAS	Enhanced recovery after surgery
FT	Fast track
POD	Postoperative day
NJEEN	Nasojejunal early enteral nutrition
POPF	Postoperative pancreatic fistula
OFA	Opioid-free anesthesia

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Introduction

Pancreaticoduodenectomy (PD) is the most suitable curative treatment for multiple benign and malignant periampullary diseases. With recent advances in surgical techniques, perioperative management, and postoperative care, PD has become increasingly common, and the mortality rate associated with this major procedure has decreased, especially in high-volume centers [1, 2]. The mortality rate after PD is less than 5%, which has been markedly improved by the centralization of pancreatic surgery. Conversely, the morbidity rate following PD remains high, reaching 30 to 50% [3, 4], owing to pancreatic fistula, hemorrhage [5], and delayed gastric emptying (DGE) [6–8].

Enhanced recovery after surgery (ERAS) program is one of the most promising approaches to optimize postoperative outcomes after abdominal surgery, whether it is elective or emergency surgery [9]. The feasibility and safety of fast-track (FT) programs have been validated in colorectal [10], hepatic [11], and pancreatic surgery [12, 13]. Fast-track perioperative care employs a number of elements aimed at enhancing recovery and reducing the profound stress response after surgery. ERAS protocols might decrease mortality, morbidity, length of hospital stay (LOS), and cost by 30 to 50% [14].

This program combines various working axes as minimally invasive techniques, optimal pain control, and early postoperative rehabilitation (e.g., early mobilization, non-routine use of postoperative nasogastric decompression, and early oral feeding). The selective use of a nasogastric tube (NGT) represents the key of enhanced recovery, because it allows early mobilization and early oral feeding, and reduces the morbidity rate [15]. Many studies have demonstrated that elective colorectal [16, 17], liver [18], and gastric [19] surgery can be safely performed without systematic postoperative nasogastric decompression. Some previous retrospective studies showed the safety of no NGT after pancreatic surgery [20, 21], but without noteworthy results in PD specifically.

The aim of the present study was to evaluate the impact of non-systematic nasogastric decompression after PD on postoperative morbidity.

Materials and methods

Patient selection

All consecutive patients who underwent PD at a single tertiary referral center between January 2014 and December 2015 were included and analyzed. Data were collected from a prospectively maintained database and analyzed retrospectively. Data such as demographics [age, sex, body mass index (BMI)], surgical variables, NGT placement, LOS, morbidity, and mortality were assessed. Indication for surgery was systematically confirmed by a multidisciplinary meeting including surgeons, gastroenterologists, and radiologists. Indications for PD were malignant or benign tumor, chronic pancreatitis, and intraductal papillary mucinous neoplasm (IPMN), with no exclusion regarding the indication. The study protocol was approved by the institutional review board.

From May 2015, the NGT was systematically withdrawn postoperatively following an FT protocol [22]. To avoid management bias, the study was restricted to patients who underwent surgery between 2014 and 2015, and patients were managed with the same protocol of postoperative care, except regarding the NGT during the study period.

Surgery

All PDs were performed according to standardized procedure by a senior pancreatic surgeon. The operative analgesia used was epidural anesthesia or intravenous xylocaine. One intravenous dose of antimicrobial prophylaxis was systematically administered during the surgery, except for patients with preoperative biliary drainage, who received also intravenous antibiotics during the first postoperative 72 h. PDs were performed according to the Whipple procedure without pylorus preservation. The child technique (i.e., pancreaticojejunal anastomosis, biliary-jejunal anastomosis, and antecolic gastrojejunal anastomosis in sequential order) was used for the reconstruction. External trans-anastomotic drainage was performed when pancreatic duct diameter was less than 3 mm with an Escat drain (Ch 5 or 6).

An NGT and a urinary catheter were systematically used during surgery. Intraoperatively, an NGT was used in all patients to maintain the gastric remnant in a decompression state. Then, a nasojejunal tube was inserted through the oesogastric tract and manually placed 15 cm downstream from the gastrojejunostomy in the efferent jejunal limb, immediately after reconstructing the posterior layer. Intra-abdominal drainage with aspirating ones (Ch 10) was routinely performed to look for postoperative pancreatic fistula as defined by the International Study Group on Pancreatic Fistula (ISGPF) [23].

Postoperative care

In the two groups, a protocol of FT was used and standardized. Postoperative care used low-molecular-weight heparin from postoperative day (POD) 0 until 1 month after discharge, and an antiemetic combination of ondansetron and/or metoclopramide. Pain control was achieved by a patient-controlled pump device with intravenous opiates or oral opiates combined with paracetamol. Urinary catheter and epidural analgesia were removed on POD 2. All patients received nasojejunal early enteral nutrition (NJEEN) after PD from POD 1 until discharge which was maintained through the nasojejunal tube, complementary to the oral feeding. Also, patients of the NGT− group had only one nasojejunal tube after surgery for enteral nutrition, and patients of the NGT+ group had two tubes after surgery, an NGT for a minimum of 3 days and a nasojejunal tube for enteral nutrition until discharge. On POD 1, NJEEN was started with 500 mL and 750 Kcal/day, increasing to 1125 Kcal/day on POD 2, and progressively increasing to 1500 Kcal/day. Assisted mobilization started on the night of the surgery with the aim of full mobilization as soon as possible.

Drain amylase level and serum amylase level were analyzed on POD 3 and POD 5 to detect postoperative pancreatic fistula (POPF). Intra-abdominal drains were removed on POD 3 if there was no POPF, or maintained if the sample confirmed POPF, until drain output was less than 50 mL per day.

In the NGT+ group, the NGT was removed on POD 3 if the NGT volume was less than 600 mL or on POD 5 in the absence of DGE. A liquid diet was initiated the same day of the NGT removal. If the liquid diet was well tolerated, the solid diet was introduced progressively. In the NGT− group, NGT was systematically removed in the operating room at the end of surgery. After surgery, on POD 0, only water was allowed. Liquid diet (water, soup, and yoghurt) was started on POD 1 and advanced as tolerated to solid diet the next day.

In the two groups, reinsertion of the NGT was done in any of the following conditions: persistent hiccups, nausea, or vomiting, and when patients requiring reintubation or relaparotomy. After reinsertion, the NGT was removed only according to clinical tolerance and if its volume was less than 600 mL per day.

Defining adverse events

Postoperative outcomes were collected during the hospital stay and follow-up period. Complications were defined as mortality (in-hospital death or death occurring within 90 days of surgery), POPF according to the recent definition of the International Study Group on Pancreatic Fistula (ISGPF) [23] and DGE according to the definition of the International Study Group of Pancreatic Surgery Classification (ISGPS) [24]. Postoperative complications were defined by the international Clavien-Dindo grading system [25].

Statistical analysis

For descriptive analyses, qualitative variables were reported as number of patients with percentages, and for quantitative

Table 1 Demographics data

Variable	Nasogastric decompression		*P* value
	NGT− (*n* = 40)	NGT+ (*n* = 99)	
Age[a]	67 [60–74.2]	67 [59.5–73]	0.48
Sex ratio (F:M)	15:25	37:62	1
BMI[a]	24.3 [20.8–26.6]	24 [22.4–26.1]	0.52
ASA score			0.81
< 2	10 (25)	21 (21.2)	
≥ 2	30 (75)	77 (77.8)	
Diabetes			0.9
No	34 (85)	81 (81.8)	
Yes	6 (15)	18 (18.2)	
Previous upper GI or HBP surgery	35 (87.5)	81 (81.8)	0.57
Jaundice	23 (57.5)	49 (49.9)	0.54
Biliary drainage	15 (37.5)	36 (36.6)	1
Preoperative chemotherapy	4 (10)	13 (13.1)	0.77
Diagnosis			0.43
Pancreatic ductal adenocarcinoma	17 (42.5)	50 (50.5)	
Cholangiocarcinoma	4 (10)	14 (14.1)	
Ampullary cancer	3 (7.5)	4 (4)	
Neuroendocrine tumor	2 (5)	2 (2)	
Other cancer	1 (2.5)	9 (9.1)	
Intraductal papillary mucinous neoplasm	6 (15)	7 (7.1)	
Chronic pancreatitis	2 (5)	3 (3)	
Other benign lesion	5 (12.5)	10 (10.1)	

Values in parentheses are percentages

BMI body mass index, *ASA* American Society of Anesthesiologists, *NGT* nasogastric tube, *GI* or *HBP* gastrointestinal or hepatobiliary-pancreatic

[a] Median [interquartile range]

Table 2 Perioperative data

Variable	Nasogastric decompression		*P* value
	NGT− (*n* = 40)	NGT+ (*n* = 99)	
Epidural analgesia	9 (22.5)	21 (21.2)	1
Length of surgery (min)[a]	300 [248.8–342.5]	270 [210–337]	0.1
Adhesiolysis	12 (30)	22 (22.2)	0.45
Vascular resection	9 (22.5)	22 (22.2)	1
Organ associated resection	1 (2.5)	9 (9.1)	0.28

Values in parentheses are percentages

NGT nasogastric tube

[a] Median [interquartile range]

variables as medians with the interquartile range (IQR). For comparisons between the NGT+ and the NGT− group, qualitative variables were compared using a chi-square test or a Fisher exact test, as appropriate, and quantitative variables were compared using a Mann-Whitney *U* test, as appropriate. A P value < 0.05 was considered statistically significant. Statistical analyses were performed using R statistical software (http://www.r-project.org/).

Results

Demographics and operative data

During the study period, 139 patients underwent PD (87 men and 52 women). Forty patients (28.8%) had early withdrawal of NGT (NGT− group), whereas 99 patients (71.2%) were classically managed with NGT during the postoperative period (control group: NGT+). Patient and surgical characteristics in each group were similar, particularly for DGE risk factors such as diabetes and age (Table 1). The median age was 67 years in the two groups. The median BMI was 24.3 [20.8–26.6] kg/m^2 and 24 [22.4–26.1] kg/m^2 in the NGT− and NGT+ groups, respectively ($P = 0.52$). There was no statistically significant difference regarding the indication for surgery, preoperative chemotherapy rate, and biliary drainage rate between the two groups.

The surgical data are summarized in Table 2. No difference was found between the two groups regarding duration of surgery, rate of vascular resection, rate of adjacent organ resection, and pre- and postoperative analgesia modalities.

Postoperative outcomes

Postoperative complications are shown in Table 3. Patients in the NGT+ group had presented more grade 2 or higher complications, 82 (82.8%) versus 16 (40%) in the NGT− group ($P < 0.001$). Rates of pancreatic fistula grades B–C according to ISGPF classification were 19.2% ($n = 19$) and 15% ($n = 6$) in the NGT+ group and the NGT− group, respectively ($P = 0.73$). The rate of DGE (grade B–C according to ISGPS

Table 3 Postoperative data

Variable	Nasogastric decompression		*P* value
	NGT− (*n* = 40)	NGT+ (*n* = 99)	
Length of stay[a] (day)	10 [8–14.2]	14 [11–25]	0.005
Surgical revision	2 (2)	19 (19.9)	0.06
Pancreatic fistula[b]			0.21
None	34 (85)	80 (80.8)	
B	6 (15)	12 (12.1)	
C	0 (0)	7 (7.1)	
Pancreatic fistula[b]			
None	34 (85)	80 (80.8)	0.73
B–C	6 (15)	19 (19.2)	
Dindo-Clavien grade			0.18
< 3a	36 (90)	78 (79)	
≥ 3a	4 (10)	21 (21)	
Dindo-Clavien grade			< 0.001
< 2	24 (60)	17 (17)	
≥ 2	16 (40)	82 (83)	
Delayed gastric emptying (grade)[c]			< 0.001
None	30 (75)	23 (23.2)	
A	7 (17.5)	31 (31.3)	
B	2 (5)	25 (25.2)	
C	1 (2.5)	20 (20.2)	
Delayed gastric emptying (grade)[c]			< 0.001
None-A	37 (92.5)	54 (54.5)	
B–C	3 (7.5)	45 (45.5)	
30-day mortality	0 (0)	3 (3)	0.56
90-day mortality	0 (0)	6 (6)	0.18

Values in parentheses are percentages

NGT nasogastric tube

[a] Median [interquartile range]

[b] According to classification ISGPF

[c] According to classification ISGPS

Table 4 Characteristics of patients requiring secondary nasogastric decompression in the two groups

Variable	NGT+	NGT−
Age, years[a]	67 [64;71]	65 [59;75]
Sex ratio H:F	7:2	17:8
Day of NGT removal, *n* (%)		
POD 3	14 (63.6)	–
POD 5	4 (18.2)	–
POD > 5	4 (18.2)	–
Delay for reintroduction of NGT (days)[b]	3.9	2.5
POPF B–C	6	2
Clavien-Dindo score, *n* (%)		
< 3a	11 (50)	8 (89)
≥ 3a	11 (50)	1 (11)
DGE grade, *n* (%)		
A	4 (18.2)	6 (67)
B	7 (31.8)	2 (22)
C	11 (50)	1 (11)
Length of hospital stay, days[a]	25 [17;37]	13 [11;19]

Values in parentheses are percentages

NGT nasogastric tube, *POD* postoperative day, *DGE* delayed gastric empty, *POPF* postoperative pancreatic fistula, *POPF* postoperative pancreatic fistula

[a] Median [interquartile range]

[b] Mean

classification) was significantly higher in the NGT+ group compared to the NGT− group (45.5 vs. 7.5%, $P < 0.001$). Consequently, the length of postoperative hospital stay was significantly shorter in the NGT− group (10 [8–14.2] vs. 14 [11–25] days, $P = 0.005$).

Concerning postoperative mortality, the 30- and the 90-day mortality rates were not different between the NGT+ and NGT − groups (3 vs. 0%, $P = 0.56$ and 6 vs. 0%, $P = 0.18$, respectively).

Nasogastric tube reinsertion

Twenty-two patients in the NGT+ group required reinsertion of an NGT after primary removal. Detailed characteristics of these patients are summarized in Table 4.

Reinsertion of an NGT was required in nine (22.5%) patients in the NGT− group, after a mean of 3 ± 1 days following surgery. Indications for NGT reinsertion are detailed in Table 5. Among these nine patients, five (55.6%) required NGT reinsertion for secondary DGE due to postoperative complication.

Discussion

A large number of studies have widely proved the feasibility, safety, and benefits of no nasogastric decompression after major abdominal surgery. Indeed, the early withdrawal of an NGT allows earlier return of gastrointestinal functions and decreases postoperative pulmonary complications [15, 26]. This approach, which has been clearly proved in many digestive surgeries (e.g., colorectal, liver, and gastric), is now recommended after pancreatic surgery (including PD) by the ERAS Society, without major data on safety. The results of the present study, which included 139 consecutive patients who underwent PD in a modern era of pancreatic surgery, provide an important set of data. In fact, the absence of NGT was associated with a lower rate of major complication, DGE,

Table 5 Detailed characteristics of patients requiring secondary nasogastric decompression in the NGT− group

Patients	Histology	Time before NGT reinsertion (days)	Length of ND (days)	Secondary DGE	Type of complications	Clavien-Dindo	LOS (days)
1	PDAC	5	2	No	PF grade A	2	14
2	PDAC	2	5	No	No	2	11
3	PDAC	1	2	No	No	2	10
4	Ampullary neoplasm	3	2	Yes	PF grade A/gastrointestinal bleeding	2	11
5	Distal cholangiocarcinoma	1	6	No	No	2	10
6	PDAC	2	14	Yes	PF grade B	2	28
7	IPMN	3	5	Yes	PF grade B	2	13
8	IPMN	2	6	Yes	Postoperative ascites	2	22
9	Neuroendocrine tumor	3	3	Yes	Evisceration	3b	19

PDAC pancreatic ductal adenocarcinoma, *IPMN* intraductal papillary and mucinous neoplasm, *ND* nasogastric decompression, *PF* pancreatic fistula, *LOS* length of hospital stay, *DGE* delayed gastric emptying and a shorter LOS. Moreover, it was not related to an increase of mortality and POPF rates.

Despite the recommendation of the ERAS Society, the absence of NGT following PD has not been widely adopted by most pancreatic surgeons. This mistrust can be related to different causes, including the lack of data in this precise indication, the type of pancreatic anastomosis performed, and, importantly, the DGE induced by this surgery. In fact, DGE is so frequent following PD (25 to 40%) that the ISGPS proposed a consensual definition in 2007 that was composed of a three-grade classification [24]. By prolonging the hospital stay, DGE negatively impact the quality of life and increase hospital costs [27]. The DGE can be idiopathic and related to the surgical procedure. Its pathophysiology of which is still not clearly understood and widely debated. Some authors hypothesize that DGE is the result of gastric denervation due to the loss of parasympathetic nerves, resulting in the reduction of peristaltic contractions and secretion of prokinetic drugs, such as motilin [28]. The classical modifications of postoperative glycemia usually observed after PD might also play a pivotal role in idiopathic DGE. In contrast, DGE may be secondary to a complication such as a POPF or an intra-abdominal abscess. The present results show that reinsertion of an NGT was necessary in 22.5% of patients, especially when postoperative complications occurred. These results suggest that maintaining an NGT in the postoperative period might represent a major factor inducing idiopathic DGE. Among the various other factors that might influence the occurrence of idiopathic DGE, the three most easily modifiable factors are the preoperative and early postoperative control of glycemia [29], the use of opioid-free anesthesia protocols (OFA) [30], and the type of gastro-enteric anastomosis used. A recent meta-analysis published by Hanna et al. suggested that antecolic reconstruction without pylorus preserving was associated with a lower incidence of clinically relevant DGE [31, 32]. These results were conflicting with a previous prospective randomized trial published in 2014 by Eshuis et al. and confirmed in *the Cochrane Database* review [33], where antecolic gastro-enteric anastomosis did not influence postoperative DGE rate [34].

During the study period, all patients underwent systematically a pylorus-resecting pancreaticoduodenectomy (PD) due to the lack of evidence on the benefits of pylorus preserving PD. The impact of pylorus preserving PD is still under debate regarding the recent literature. Results of the most recent randomized controlled trial comparing pylorus-resecting or pylorus-preserving PD did not showed any significant difference on DGE occurrence [35]. However, an up-to-date meta-analysis [36] including all studies concluded to the superiority of the pylorus-resecting PD regarding the DGE rate.

Regarding anesthesia modalities and ERAS protocol, the goal at the present time is to obtain optimal analgesia that allows rapid rehabilitation without pain, through the use of drugs and/or techniques to avoid the need for opioid medications [37]. In particular, OFA using dexmedetomidine, lidocaine, and propofol infusions may be an interesting alternative in digestive surgery [38]. However, to date, no work has evaluated the feasibility of this protocol in pancreatic surgery.

The feasibility of the early withdrawal of the NGT after PD was previously suggested by Kunstman et al. in a retrospective study [21]. In their study, the rate of DGE was lower in the selective NGT group, but without significant difference concerning overall postoperative morbidity using the Clavien-Dindo classification. Although the size of the study population was larger than ours (250 patients), the main limitation of their work is a fairly long recruitment period (9 years). During this long inclusion period, the overall management of postoperative care has significantly changed which have inevitably induced bias and limit the evaluation of the impact of an NGT decompression on morbidity. As previously reported [39], the systematic use of early enteral nutrition via a nasojejunal tube could be an alternative hypothesis to explain the lower rate of idiopathic DGE. However, these results have not been confirmed in a recent controlled randomized study [40].

Obviously, our study presents some limitations. First, the retrospective and the monocentric character of this study is one of its critical points. Second, the limited number of patients, especially in the NGT− group, could induce bias. On the other hand, the short and recent period of recruitment may limit these biases. These encouraging results need to be validated by a controlled randomized trial, which was started in our center in January 2016 (NCT: 02594956).

In conclusion, pending the results of a randomized controlled trial, a systematic nasogastric decompression after PD might be avoided in most cases of PD, reducing postoperative DGE and the length of hospital stay.

Author's contributions Study concept and design: EG and LS; acquisition of data: EG; analysis and interpretation of data: EG, DB, and LS; drafting of the manuscript: EG, FR, DB, and LS; critical revision of the manuscript for important intellectual content: LT, AM, HB, BM, KB, LS, and MR; statistical analysis: DB; final revision and final approval for publication: LS

Compliance with ethical standards

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. For this type of study, formal consent is not required.

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

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