World J Surg (2019) 43:2616–2622
https://doi.org/10.1007/s00268-019-05045-4

ORIGINAL SCIENTIFIC REPORT

Nasogastric Tube on Demand is Rarely Necessary After Pancreatoduodenectomy Within an Enhanced Recovery Pathway

D. Kleive[1,2] · Mushegh A. Sahakyan[3] · K. J. Labori[1] · K. Lassen[1,4]

Published online: 3 June 2019

Abstract

Background Evidence-based guidelines for enhanced recovery (ERAS) pathways after pancreatoduodenectomy (PD) are available. Routine use of nasogatric tube (NGT) after PD is not recommended. This study aims to evaluate the need for NGT reinsertion after PD performed within an ERAS setting.
Methods It is a prospective observational study of all patients undergoing PD in a tertiary referral hospital within the study period from 2015 throughout 2016. Pre- and postoperative variables were collected. Patients requiring NGT reinsertion were identified. Comparative analysis of patients with and without a NGT reinsertion was performed, as well as multivariate analysis for risk factors for on-demand NGT reinsertion.
Results Two-hundred and one patients were included. In total, 45 (22.4%) patients required NGT reinsertion after PD. A total of 32 (15.9%) patients underwent a relaparotomy. Reinsertion of NGT in patients not undergoing a relaparotomy occurred in 26 (15.4%) patients. The presence of a major postoperative complication was a risk factor for reinsertion of NGT, OR 5.27 (2.54–10.94, $p = 0.001$). Patients with the need for a NGT reinsertion had a higher frequency of major postoperative complications and relaparotomy compared to patients without the need of a NGT reinsertion, 26 (57.8%) versus 32 (20.5%), $p < 0.001$ and 19 (42.2%) versus 13 (8.3%), $p < 0.001$, respectively.
Conclusion Routine use of NGT after PD is not justified within an ERAS setting. Immediate removal of the NGT after the procedure can be performed safely, and reinsertion on demand is rarely necessary in uncomplicated courses.

Introduction

Enhanced recovery pathways after surgery (ERAS) have gained increased popularity within the last decade. The use of an ERAS protocol shorten hospital length of stay without compromising postoperative morbidity and mortality, even after complex surgical procedures like pancreatoduodenectomy (PD) [1]. Evidence-based guidelines have provided a uniform platform for perioperative care for PD [2], addressing a large number of procedural items for the surgical pathway. Recent studies, investigating the effect of some of these items, have identified an improvement in clinical outcomes and a reduction in postoperative complications for patients with adherence to the ERAS protocol used [3, 4].

D. Kleive and Mushegh A. Sahakyan have contributed equally to this work.

✉ D. Kleive
dyrekleive@hotmail.com

1 Department of Hepato-Pancreato-Biliary Surgery, Rikshospitalet, Oslo University Hospital, Oslo, Norway

2 Institute of Clinical Medicine, University of Oslo, Oslo, Norway

3 Department of Surgery N1, Yerevan State Medical University After M. Heratsi, Yerevan, Armenia

4 Institute of Clinical Medicine, The Arctic University of Norway, Tromsø, Norway

Some of the elements recommended by the ERAS guidelines have been notoriously difficult to implement. One of these is abolishing the routine use of nasogastric tube (NGT). This was documented to be safe after most abdominal operations a decade ago [5], but there were very limited data for PD patients at the time. The 2013 ERAS guidelines, however, strongly advised against preemptive use of nasogastric tubes postoperatively as it does not improve outcomes and may impede recovery [2]. Later studies have supported the recommendation of avoiding routine nasogastric decompression after pancreatic surgery [6–8]. These studies are limited, however, by small sample-size and often involve comparison with historical cohorts. Data on the effects of immediate removal of the NGT before endotracheal extubation in an ERAS setting are scarce. A selected adaptation of key elements from the 2012-guidelines is often used in publications covering the implementation of ERAS in PD. However, while most local protocols dictate removal of the NGT on the day of surgery, the data on the actual removal of the tube reveals that this frequently occurs on postoperative day (POD) 1–3 or at the surgeons discretion, for various reasons [3, 4, 9]. Thus, an inherent resistance to immediate (intraoperatively before endotracheal extubation) removal of the NGT exists, even within an ERAS setting. The aim of this study was to evaluate the consequences of immediate NGT removal after PD in an enhanced recovery pathway and to assess the need for on-demand reinsertion.

Materials and methods

This is a prospective observational study of all consecutive patients undergoing PD at Oslo University Hospital, Rikshospitalet, from January 2015 throughout December 2016. The hospital is a tertiary referral hospital and sole provider of major hepato-pancreato-biliary (HPB) surgery for 2.8 million people within the South-Eastern Health Trust in Norway. Patients with other types of pancreatic resections were excluded. Hospital records with relevant pre- and postoperative variables were prospectively registered. The hospital review board approved the study according to the general guidelines provided by the regional ethics committee. The manuscript was completed in accordance with the STROBE statement [10].

Surgical technique

All patients were preoperatively evaluated in a multidisciplinary meeting. Preoperative workup included a multidetector computed tomography (CT) with an optimized pancreatic protocol and a chest CT. For patients with pancreatic ductal adenocarcinoma, both primary and borderline resectable pancreatic cancer, as defined by the NCCN criteria [11], were included in this cohort. Patients with borderline resectable disease were considered for four cycles of neoadjuvant chemotherapy, preferably FOLFIRINOX before reevaluation of the disease and possible exploration and resection. A mid-line, upper transverse or reversed L-shaped incision was used according to surgeon's preference. A pylorus-preserving pancreatoduodenectomy or a classic Whipple's procedure with a standard lymphadenectomy was performed. In the case of suspicion of tumor involvement of mesenterico-portal vein axis, a resection of the involved vein was performed. Arterial resection was performed in highly selected patients.

Enhanced recovery pathway

Preoperative

Dedicated preoperative counseling was performed 1–3 weeks before surgery by a staff surgeon, anesthesiologist and a trained nurse with specific knowledge of key elements of ERAS protocol. Preoperative biliary drainage was not performed routinely, but individually considered for patients with bilirubin concentration ≥ 250 µmol. Cessation of smoking and excessive alcohol intake was recommended for all patients. Dietary counseling was given routinely. Preoperative nutrition was not administered routinely. No bowel preparation was used. Patients were fasted for solid diet from midnight before surgery, but preoperative treatment with oral carbohydrate rich solutions was provided for all nondiabetic patients. Short-acting anxiolytics at the day of surgery were used according to patient preference. Low-molecular weight heparin (LMWH) at 100 Units/kg was administered the night before surgery, 6 h after surgery and continued daily for 4 weeks after hospital discharge. Prior to skin incision, a mid-thoracic epidural was placed. Hypothermia during the procedure was prevented using a forced-air patient warming system (3 M™BairHugger™, 3 M, USA). Peroperative intravenous antibiotic prophylaxis was administered 2 h prior to surgery.

Postoperative

The NGT was removed immediately after skin closure and before endotracheal extubation. Patient controlled analgesia (PCA), wound catheters, transverse abdominal block or other intravenous analgesics were not used routinely. Administration of antiemetics during the day of the procedure was based on patient preference. Avoidance of hyperglycemia and near-zero fluid balance was strictly supervised during the initial postoperative period (POD 1–3), and patients were discharged from the high-dependency unit to a step-down room (1 on 1 nursing facilities) in order to optimize this. A drain was placed underneath the hepaticojejunostomy and above the pancreaticojejunostomy at the end of the procedure and early drain removal (POD 3) was warranted for all patients with normal drain amylasis. Somastotain analogues were considered standard of care throughout the study period (but have since then been abandoned). A transurethral catheter was inserted at the day of surgery and removed as soon as possible. Oral laxatives were not prescribed routinely, but according to patient performance. Early mobilization was initiated on the morning of POD 1, and patients were encouraged to meet daily targets for mobilization. There were no dietary restrictions after surgery, but patients were encouraged to begin carefully and increase intake according to tolerance over POD 1–4. Routine administration of artificial nutrition was not recommended but given according to surgeon's preference. As a general rule, well-nourished patients not achieving adequate energy/protein requirement by oral intake within 5 days after the operation received artificial nutritional support. Malnourished patients and those who developed severe postoperative complications early after operation received early supplementary artificial nutrition. Patients were discharged to their home or to their local hospital at the time of functional recovery.

NGT reinsertion

The decision to reinsert the NGT in the postoperative course was based on surgeon's preference according to clinical symptoms. For patients undergoing a relaparotomy, NGT reinsertion was routinely performed in order to facilitate gastric decompression. Provided patients were not sedated following a relaparotomy, NGTs were removed after surgery. Patients with reinserted NGT that remained during the following postoperative phase were registered as having a NGT reinsertion. Specific indications or symptoms responsible for NGT reinsertion, as well as exact volume output on NGT, were not systematically registered in the study period.

Definitions

Severe cardiac disease (NYHA class >2 or severe arrhythmia) and pulmonary disease (FEV1 $< 50\%$ and/or vital capacity $< 60\%$) were defined in concordance with the mE-PASS system [12]. Diabetes mellitus was considered present if medically treated. Preoperative performance status was evaluated using the grading system provided by the Easter Cooperative Oncology Group [13]. Type of venous resection was classified as proposed by the ISGPS [14]. Complications were classified according to the accordion severity grading system [15]. Accordion grade ≥ 3 complications were registered and considered a major postoperative complication. Postpancreatectomy hemorrhage, delayed gastric emptying (DGE) and clinically relevant pancreatic fistula were recorded according to the ISGPS-definitions [16–18]. Thirty- and 90-day mortality was assessed. Length of hospital stay was defined as the number of days after surgery until discharge home or to the local hospital. Days spent in local hospital following transfer are not accounted for.

Statistical analysis

Descriptive statistics were used to summarize the data. Median (range) or mean (±standard deviation) values were used to express numerical data, where appropriate. Numbers (percentages) were applied for categorical data. Two-sample Student's *t* test and Man-Whitney *U* test were used to compare normally and not normally distributed numerical data, respectively. The Chi-square test or Fisher's exact test was used to examine differences between the categorical variables. Two-tailed $p < 0.05$ was considered statistically significant.

Parameters that were significant in the univariable analysis were added to the multivariable logistic regression model to identify predictors for NGT reinsertion after PD. Two-tailed $p < 0.05$ was considered statistically significant in the multivariable analysis.

Results

A total number of two-hundred and one patients underwent PD throughout the study period. Patient characteristics and intraoperative data are shown in Table 1. Ductal adenocarcinoma was the most common indication for surgery (41.3%). Major postoperative complications, relaparotomy and 90-day mortality were observed in 28.9%, 15.9% and 5.5% of patients, respectively (Table 2). DGE clinically grade B and C were observed in 18.4% and 12.8% of patients, respectively.

Forty-five (22.4%) patients had a NGT reinsertion following PD including 19 that eventually underwent relaparotomy. Among those that did not undergo relaparotomy (169 patients), NGT was reinserted in 26 (15.4%) cases. In total, 19 (9.4%) patients without a major complication had reinsertion of a NGT (Table 2). The median time of NGT reinsertion after PD was POD 5. Female gender and younger age were significantly associated with a course without an NGT reinsertion, while intraoperative

Table 1 Pre- and intraoperative characteristics of patients undergoing pancreatoduodenectomy

Variables	(n = 201)
Age, years, mean (SD)	67.1 (9.5)
Gender, *n* (%)	
Female	99 (49.3%)
Male	102 (50.7%)
BMI, kg/m^2, mean (SD)	24.5 (3.8)
Severe pulmonary disease, *n* (%)	3 (1.5%)
Severe cardiac disease, *n* (%)	11 (5.5%)
Diabetes mellitus, *n* (%)	36 (17.9%)
Neoadjuvant chemotherapy, *n* (%)	11 (5.5%)
ECOG score	
0	157 (78.1%)
1	39 (19.4%)
2	4 (2.0%)
3 and 4	1 (0.5%)
Peroperative biliary stent, *n* (%)	88 (43.8%)
ASA* score, *n* (%)	
1	3 (1.5%)
2	103 (51.5%)
3 and 4	94 (47%)
Serum albumin, mean (SD)	39.2 (4.8)
Tumor histology, *n* (%)	
Pancreatic ductal adenocarcinoma	83 (41.3%)
Common bile duct cancer	36 (17.9%)
Duodenal cancer	24 (11.9%)
Ampullary cancer	9 (4.5%)
Other malignancy	20 (10%)
IPMN**	5 (2.5%)
Chronic pancreatitis/other benign diseases	24 (12%)
Type of procedure, *n* (%)	
Standard	63 (31.3%)
Pylorus preserving	138 (68.7%)
Operative time, min, mean (SD)	353 (86)
Estimated blood loss, ml, median (range)	200 (50–3700)
Patients receiving red blood cell transfusion, *n* (%)	38 (18.9%)
Venous resection, *n* (%)	45 (22.4%)
Type 1	10 (5%)
Type 2	3 (1.5%)
Type 3	26 (12.9%)
Type 4	6 (3%)
Arterial resection, *n* (%)	14 (7%)

*American society of anesthesiologists, **intraductal papillary mucinous neoplasia

Table 2 Postoperative outcomes in patients undergoing pancreatoduodenectomy

Variables	(n = 201)
Reinsertion of nasogastric tube, *n* (%)	45 (22.4%)
Reinsertion of NG tube in patients not undergoing a relaparotomy, n = 169 (%)	26 (15.4%)
Reinsertion of NG tube in patients not experiencing a major complication (%)	19 (9.4%)
Days to reinsertion of nasogastric tube, median (range)	5 (1–42)
Days with reinserted nasogastric tube, median (range)	3.5 (1–21)
Any use of parenteral nutrition after surgery, *n* (%)	98 (48.8%)
Days from surgery to starting parenteral nutrition, median (range)	4 (1–10)
Major postoperative complications, *n* (%)	58 (28.9%)
Postoperative hemorrhage (grade B/C), *n* (%)	24 (12%)
Delayed gastric emptying, *n* (%)*	36 (18.4%)
Grade A	11 (5.6%)
Grade B	18 (9.2%)
Grade C	7 (3.6%)
Clinically relevant pancreatic fistula (grade B/C)	21 (10.5%)
30-day mortality, *n* (%)	5 (2.5%)
90-day mortality, *n* (%)	11 (5.5%)
Relaparotomy, *n* (%)	32 (15.9%)
Cause of relaparotomy, *n* (%)	
Hemorrhage	13 (6.5%)
Pancreatic fistula	5 (2.5%)
Biliary leakage	1 (0.5%)
Wound dehiscence	4 (2.0%)
Other	9 (4.4%)
Length of hospital stay, days, median (range)	7 (4–92)

*Data were missing in five patients

parameters were comparable to those with NGT reinsertion (Table 3). The latter was associated with postoperative complications, grade B/C postoperative hemorrhage and relaparotomy. In the multivariable model, only male gender and postoperative complications were independent predictors for NGT reinsertion after PD (Table 4). For patients without a major complication, the reinsertion rate was significantly higher in older patients, mean (SD) 71.4 years (6.4) versus 66.2 (10.6), $p = 0.04$ and patients with an ECOG score ≥ 1 (42.1% and 19.4%, $p = 0.04$), data not shown.

Discussion

In this study, we found that immediate removal of the NGT after PD could be accomplished without the need for subsequent reinsertion in the vast majority of the patients not experiencing a relaparotomy. Furthermore, the rates of major complications, relaparotomies and 90-day mortality after PD in our study are in line with those reported by others [19, 20], indicating that a routine of NGT on-

Table 3 Comparative analysis of patients with and without nasogastric tube reinsertion

Variables	NG-tube reinsertion (*n* = 45)	No reinsertion (*n* = 156)	p value
Age, years, mean (SD)	69.4 (6.8)	66.4 (10.1)	0.023
Gender, *n* (%)			0.006
Female	14 (31.1%)	85 (54.5%)	
Male	31 (68.9%)	71 (45.5%)	
BMI, kg/m^2, mean (SD)	25.4 (4.4)	24.3 (3.6)	0.61
Severe pulmonary disease, *n* (%)	1 (2.2%)	2 (1.3%)	0.54
Severe cardiac disease, *n* (%)	3 (6.7%)	8 (5.1%)	0.71
Diabetes mellitus, *n* (%)	10 (22.2%)	26 (16.7%)	0.39
Neoadjuvant chemotherapy, *n* (%)	1 (2.2%)	10 (6.4%)	0.46
ECOG score			0.2
0	32 (71.1%)	125 (80.1%)	
$\geq$ 1	13 (28.9%)	31 (19.9%)	
Peroperative biliary stent, *n* (%)	17 (37.8%)	71 (45.5%)	0.4
ASA score, *n* (%)			0.18
½	20 (44.4%)	87 (55.8%)	
¾	25 (55.6%)	69 (44.2%)	
Serum albumin, mean (SD)	39.5 (4.6)	39.1 (4.9)	0.31
Tumor histology, *n* (%)			0.38
PDAC	16 (35.6%)	67 (42.9%)	
Other	29 (64.4%)	89 (57.1%)	
Type of procedure, *n* (%)			0.49
Standard	16 (35.6%)	47 (30.1%)	
Pylorus preserving	29 (64.4%)	109 (69.9%)	
Operative time, min, mean (SD)	372 (81.1)	347 (86.3)	0.68
Blood loss, ml, median (range)	350 (50–3100)	200 (50–3700)	0.07
Red blood cell transfusion, *n* (%)	8 (18.2%)	30 (19.5%)	0.85
Venous resection, *n* (%)	13 (28.9%)	32 (20.5%)	0.25
Patch/Interposition graft	2 (15.4%)	7 (21.9%)	
Arterial resection, *n* (%)	4 (8.9%)	10 (6.4%)	0.52
Major postoperative complications, *n* (%)	26 (57.8%)	32 (20.5%)	<0.001
Postoperative hemorrhage (grade B/C), *n* (%)	11 (24.4%)	13 (8.3%)	0.003
Clinically relevant pancreatic fistula (grade B/C)	8 (17.8%)	13 (8.3%)	0.09
Delayed gastric emptying, *n* (%)*	24 (55.8%)	12 (7.8%)	<0.001
Grade A	9 (20.9%)	2 (1.3%)	<0.001
Grade B/C	15 (34.9%)	10 (6.5%)	<0.001
Relaparotomy, *n* (%)	19 (42.2%)	13 (8.3%)	<0.001

*Data were missing in five patients

Table 4 Multivariate analysis of risk factors for nasogastric tube reinsertion

Variables	Odds ratio (95% CI)	p value
Age >65 years	1.80 (0.86–3.77)	0.192
Gender (male)	2.80 (1.37–5.73)	0.008
Major postoperative complications	5.27 (2.54–10.94)	0.001

demand-only in the immediate postoperative course after PD, does not compromise safety.

The issue of NGT usage within an ERAS pathway includes some key aspects. Firstly, the 2012 recommendations clearly advised that NGTs placed during surgery should be removed before reversal of anesthesia. Some recent reports show a surprising unwillingness to adhere to these recommendations, as the NGT is reported removed on POD 1–3 event within alleged ERAS protocols for PD

[3, 4, 9, 21]. The reasons for this remain unclear, but surgeons' preference and the desire to monitor potential bleeding from the gastrojejunal anastomosis are reported. Secondly, even though previous publications support safe removal of NGT immediately after PD, the proportion that will subsequently require reinsertion of an NGT on demand remains unknown, even within an ERAS setting. Highlighting and identifying this subgroup of patients might elucidate reasons for reinsertion of NGT and evaluate potential causes for nonadherence to modern guidelines. In this study, approximately one out of five patients needed reinsertion of the NGT after PD. This number is in accordance with a recent publication investigating the outcomes of patients undergoing PD without nasogastric decompression [6]. The authors demonstrated that reinsertion of NGT was required in 22.5% of patients who underwent a PD with immediate removal of the NGT after operation. The indications for reinsertion were secondary DGE due to postoperative complications. In our study population, the majority of patients undergoing a relaparotomy had an NGT reinserted (19 of 32 patients). This leaves 26 (15.4%) patients with other reasons than relaparotomy for reinsertion of NGT. This number is fairly low, indicating compliance with the 2013 ERAS guidelines [2] is possible and justified.

The benefits of early parenteral nutrition after PD have been widely investigated. A review of different feeding routes after PD found no evidence to support either enteral or parenteral feeding compared to regular oral diet [22]. In this cohort, 48.8% of the patients were started on total parenteral nutrition (TPN) in the postoperative period. This is surprisingly high compared to a recent large cohort study on 1184 patients undergoing PD who found that a total of 17.6% of the patients was given TPN in the postoperative period [23]. The median time of initiation of TPN was POD 4 compared to POD 5 in our cohort. The most frequent reasons for initiation of TPN were delayed gastric emptying, pancreatic fistula and generalized malnutrition [23]. Although not recommended in a routine setting, TPN may be an important adjunct to aid in the recovery of patients who are unable to progress to an oral diet after PD, as suggested by others [23]. Nevertheless, the relatively high number of patients initiated on TPN in this study most likely indicates an overuse in some patients who would strictly not have needed this support. Also, the wide availability of dedicated clinical nutritionists for patients undergoing pancreatic surgery at our center may boost use of artificial nutritional support. Identifying patients who would benefit of TPN can be challenging. Adverse events like hyperglycemia and central line associated bloodstream infection are reported [23], which suggests that initiation of TPN needs careful justification.

An important limitation of this study lies in its design. In-depth analyses of reasons for NGT reinsertion and removal as well as TPN administration are not attempted as these decisions were according to surgeon's preference, and further details were not recorded. It is a natural assumption that on-demand reinsertion of a NGT in a patient not experiencing a major complication or a relaparotomy signals some degree of subjectively experienced DGE. As discussed above, we hesitate to interpret the rather high rate of parenteral nutrition use as an indication of the same. In spite of these limitations, this study adds support to the modern approach of immediate removal of NGTs after PD and shows that only a small proportion of uncomplicated cases will be in need of NGT reinsertion on demand within an enhanced recovery pathway.

Compliance with ethical standards

Conflict of interest All authors declare that they have no conflicts of interest.

References

1. Coolsen MM, van Dam RM, van der Wilt AA et al (2013) Systematic review and meta-analysis of enhanced recovery after pancreatic surgery with particular emphasis on pancreaticoduodenectomies. World J Surg 37:1909–1918. https://doi.org/10.1007/s00268-013-2044-3
2. Lassen K, Coolsen MM, Slim K et al (2013) Guidelines for perioperative care for pancreaticoduodenectomy: enhanced recovery after surgery (ERAS(R)) society recommendations. World J Surg 37:240–258. https://doi.org/10.1007/s00268-012-1771-1
3. Agarwal V, Thomas MJ, Joshi R et al (2018) Improved Outcomes in 394 pancreatic cancer resections: the impact of enhanced recovery pathway. J Gastrointest Surg 22:1732–1742
4. Dai J, Jiang Y, Fu D (2017) Reducing postoperative complications and improving clinical outcome: enhanced recovery after surgery in pancreaticoduodenectomy –a retrospective cohort study. Int J Surg (Lond, Engl) 39:176–181
5. Nelson R, Edwards S, Tse B (2007) Prophylactic nasogastric decompression after abdominal surgery. Cochrane Database Syst Rev 3:Cd004929
6. Gaignard E, Bergeat D, Courtin-Tanguy L et al (2018) Is systematic nasogastric decompression after pancreaticoduodenectomy really necessary? Langenbeck's Arch Surg 403:573–580
7. Park JS, Kim JY, Kim JK et al (2016) Should gastric decompression be a routine procedure in patients who undergo pylorus-preserving pancreatoduodenectomy? World J Surg 40:2766–2770. https://doi.org/10.1007/s00268-016-3604-0
8. Roland CL, Mansour JC, Schwarz RE (2012) Routine nasogastric decompression is unnecessary after pancreatic resections. Arch Surg (Chic IL) 147:287–289
9. Williamsson C, Karlsson N, Sturesson C et al (2015) Impact of a fast-track surgery programme for pancreaticoduodenectomy. Br J Surg 102:1133–1141
10. von Elm E, Altman DG, Egger M et al (2007) The strengthening the reporting of observational studies in epidemiology (STROBE)

statement: guidelines for reporting observational studies. Lancet (Lond Engl) 370:1453–1457
11. National Comprehensive Cancer Network. NCCN clinical practice guidelines in oncology. Pancreatic adenocarcinoma version 2.2017. http://www.nccn.org/professionals/physicians_gls/pdf/pancreatic.pdf. Accessed September 17, 2017
12. Haga Y, Ikejiri K, Wada Y et al (2011) A multicenter prospective study of surgical audit systems. Ann Surg 253:194–201
13. Oken MM, Creech RH, Tormey DC et al (1982) Toxicity and response criteria of the eastern cooperative oncology group. Am J Clin Oncol 5:649–655
14. Bockhorn M, Uzunoglu FG, Adham M et al (2014) Borderline resectable pancreatic cancer: a consensus statement by the international study group of pancreatic surgery (ISGPS). Surgery 155:977–988
15. Strasberg SM, Linehan DC, Hawkins WG (2009) The accordion severity grading system of surgical complications. Ann Surg 250:177–186
16. Bassi C, Marchegiani G, Dervenis C et al (2017) The 2016 update of the international study group (ISGPS) definition and grading of postoperative pancreatic fistula: 11 Years after. Surgery 161:584–591
17. Wente MN, Veit JA, Bassi C et al (2007) Postpancreatectomy hemorrhage (PPH): an international study group of pancreatic surgery (ISGPS) definition. Surgery 142:20–25
18. Wente MN, Bassi C, Dervenis C et al (2007) Delayed gastric emptying (DGE) after pancreatic surgery: a suggested definition by the international study group of pancreatic surgery (ISGPS). Surgery 142:761–768
19. Kagedan DJ, Goyert N, Li Q et al (2017) The impact of increasing hospital volume on 90-day postoperative outcomes following pancreaticoduodenectomy. J Gastrointest Surg 21:506–515
20. van der Geest LG, van Rijssen LB, Molenaar IQ et al (2016) Volume-outcome relationships in pancreatoduodenectomy for cancer. HPB 18:317–324
21. Zouros E, Liakakos T, Machairas A et al (2016) Improvement of gastric emptying by enhanced recovery after pancreaticoduodenectomy. Hepatobiliary Pancreat Dis Int 15:198–208
22. Gerritsen A, Besselink MG, Gouma DJ et al (2013) Systematic review of five feeding routes after pancreatoduodenectomy. Br J Surg 100:589–598
23. Worsh CE, Tatarian T, Singh A et al (2017) Total parenteral nutrition in patients following pancreaticoduodenectomy: lessons from 1184 patients. J Surg Res 218:156–161