

Position statement

Delayed gastric emptying (DGE) after pancreatic surgery: A suggested definition by the International Study Group of Pancreatic Surgery (ISGPS)

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Background. Delayed gastric emptying (DGE) is one of the most common complications after pancreatic resection. In the literature, the reported incidence of DGE after pancreatic surgery varies considerably between different surgical centers, primarily because an internationally accepted consensus definition of DGE is not available. Several surgical centers use a different definition of DGE. Hence, a valid comparison of different study reports and operative techniques is not possible.

Methods. After a literature review on DGE after pancreatic resection, the International Study Group of Pancreatic Surgery (ISGPS) developed an objective and generally applicable definition with grades of DGE based primarily on severity and clinical impact.

Results. DGE represents the inability to return to a standard diet by the end of the first postoperative week and includes prolonged nasogastric intubation of the patient. Three different grades (A, B, and C) were defined based on the impact on the clinical course and on postoperative management.

Conclusion. The proposed definition, which includes a clinical grading of DGE, should allow objective and accurate comparison of the results of future clinical trials and will facilitate the objective evaluation of novel interventions and surgical modalities in the field of pancreatic surgery. (Surgery 2007;142:761-8.)

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FUNCTIONAL GASTROPARESIS is found in patients with diabetes mellitus, in those with disorders of

the central and peripheral nervous systems, in those in renal failure, and as a side effect of various medications; it may also arise without an obvious etiology.¹⁻³ Delayed gastric emptying (DGE) without mechanical obstruction can occur in the postoperative period after upper gastrointestinal tract surgery, such as after gastric surgery with vagotomy or esophageal resections.⁴⁻⁹ Postoperative DGE is especially common after pancreatic surgery and can prolong hospitalization.^{10,11}

Recently, consensus definitions for major complications in pancreatic surgery have been proposed for

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Table I. Reported definitions of postoperative DGE after pancreatic resection

Study	Definition
Miedema et al (1992) ¹⁸	Inability to tolerate full oral intake > POD 14
Yeo et al (1993) ²⁹	(1) NGT \geq POD 10 plus one of the following: (a) emesis after NGT removal, (b) use of prokinetics > POD 10, (c) reinsertion of NGT, (d) failure to progress with diet; (2) NGT < POD 10 plus two of (a) to (d)
Patel et al (1995) ⁶⁷	Not tolerating oral fluids by POD 7
Van Berge Henegouwen et al (1997) ³⁸	NGT \geq POD 10 or inability to tolerate regular diet \leq POD 14
Sadowski et al (1997) ³⁹	NGT > POD 5 with NGT output > 500 mL/d
Fabre et al. (1999) ⁵⁶	NGT \geq POD 10 or reinsertion because of vomiting
Horstmann et al (1999) ⁴²	NGT > POD 7 or delay of a regular diet > POD 14
Jimenez et al (2000) ⁴⁰	No significant oral intake > POD 14 requiring total parenteral nutrition
Martignoni et al (2000) ²⁵	NGT > POD 10, vomiting > 3 consecutive days after the POD 5, and x-ray passage revealing hold-up of the contrast medium in the stomach
Goei et al (2001) ⁵⁰	NGT \geq POD 10 or inability to tolerate regular diet \geq POD 14
Balcom et al (2001) ⁴¹	Inability to tolerate oral intake \geq POD 14
Buchler et al (2003) ²⁰	NGT > POD 10 or need for NGT reinsertion after POD 10
Niedergethmann et al (2006) ⁴⁶	NGT > POD 3, reinsertion of NGT, or medical stimulation owing to DGE with metoclopramide, neostigmine, and/or erythromycin
Tani et al (2006) ⁴⁸	(a) aspiration >500 mL/d from NGT left \geq POD 10; (b) reinsertion of NGT; (c) failure of unlimited oral intake by POD 14

DGE, Delayed gastric emptying; POD, Postoperative day; NGT, Nasogastric tube.

pancreatic fistula and postpancreatectomy hemorrhage.^{12,13} A universally accepted, objective, consensus definition of DGE after major pancreatic surgery, however, is not available currently; in contrast, numerous definitions of DGE have been adopted in various studies, rendering the comparison of results of different studies impossible (Table I); this inconsistency has confounded the ability to compare complication rates and outcomes of new operative approaches, operative techniques, and clinical trials.

With advances in operative techniques, intensive care medicine, interventional radiology, and better patient selection and preparation, the perioperative mortality of pancreatic surgery in high-volume centers has decreased markedly over the past two decades to <5%.¹⁴⁻¹⁷ Despite this improvement in mortality, postoperative morbidity remains high (30%-50%).¹⁴⁻²² In addition to pancreatic fistula and postoperative hemorrhage, DGE is one of the most common postoperative complications after pancreatic surgery, occurring in 19%-57% of patients.^{18,19,23-27}

The mechanisms of postoperative gastroparesis, gastric stasis, and DGE are still poorly understood. Treatment with prokinetic drugs such as the motilin receptor agonist erythromycin has been shown to reduce the incidence of DGE, supporting the hypothesis that duodenal resection, the length of the remaining duodenum, and the postoperative

decrease in plasma motilin levels may be one of the triggers of DGE.²⁸⁻³³ This hypothesis is supported by the observation that patients undergoing distal pancreatectomy rarely develop DGE. In addition, comparative studies of duodenum-preserving pancreatic head resection versus pancreatoduodenectomy suggest a lesser rate of DGE after duodenum-preserving pancreatic head resection.^{23,34-37} DGE occurs after both classic (with antrectomy) and pylorus-preserving pancreatoduodenectomy. Several studies have suggested a higher incidence of DGE after pylorus-preserving than after classic pancreatoduodenectomy,^{35,38-41} whereas others found the opposite effect on DGE.⁴²⁻⁴⁶ Other operative factors may also impact the rate of DGE, such as the method of reconstruction of gastric drainage (antecolic versus retrocolic)^{47,48} and other specific techniques (Billroth I vs II type reconstruction or mechanical dilatation of the pylorus)⁴⁹⁻⁵² and details of the clinical pathway utilized by the healthcare team.²⁵ DGE after pylorus-preserving pancreatoduodenectomy has been attributed, in part, to devascularization and denervation of the pylorus with subsequent pylorospasm.⁵³⁻⁵⁵ Supporting this concept, recent reports comparing standard pylorus-preserving pancreatoduodenectomy with the addition of pyloric dilatation or pyloromyotomy suggested a decrease in incidence of DGE after these modified techniques (26% vs 7% and 25% vs 2%, respectively).^{16,52,55}

Several reports suggested that other postoperative complications increase the incidence of DGE.^{38,52,56-59} DGE is often, but not always, associated with pancreatic fistula, peripancreatic collections, or intraabdominal abscess. In most patients, DGE is not a life-threatening complication in itself; however, DGE can cause discomfort, increase the duration of postoperative hospitalization, increase hospital costs, and decrease quality of life postoperatively.

Currently, with fast-track surgery and reduced durations of hospital stay becoming increasingly common for patients undergoing pancreatic surgery, the direct association between DGE and prolongation of hospital stay has substantive economic impact. International differences regarding the duration of the postoperative hospital stay must be acknowledged when considering this topic. The median postoperative hospital stay after pancreatoduodenectomy in Western Europe is 14-21 days,^{17,26,60-62} averages 7-14 days in the United States in recent reports,^{41,55,63-65} and in most Asian countries remains longer, ranging from 19 to 28 days.^{48,66} Nevertheless, the presence or absence of DGE can still be defined.

The great variation of reported incidences and severities of DGE is caused in great part by a lack of a uniform definition of DGE. Our aim was to develop a generally acceptable, objective consensus definition of postoperative DGE after major pancreatic surgery.

METHODS

An extensive, unlimited Medline search was performed to identify the existing literature on and definitions of DGE. The search strategy was set up by using a combination of text words combined with a medical subject headings database search. Reference lists of the retrieved literature were cross-searched manually for additional publications. All available major publications in the past 2 decades from high-volume surgical centers with an appropriate number of patients in the study were used as the basis for arriving at a suggested definition.

An international working group was established. All participating surgeons are specialists from high-volume centers with considerable experience in pancreatic surgery and scientific research. All reviewed the available literature and contributed to the consensus definition. Multiple draft definitions were circulated among the participants, and all comments were taken into account, such that the final version of the definition of DGE was agreed

on by all members of the study group and consensus reached.

RESULTS

Literature review

Terminology: The terms used most commonly to identify the complication were *delayed gastric emptying* and *gastroparesis*. In the reviewed literature, DGE was classified regarding (1) the duration of nasogastric intubation and/or need for reinsertion of a *nasogastric tube* (NGT), and (2) the postoperative day (POD) when *oral intake* of solid food was tolerated after pancreatic resection.

Nasogastric tube: According to the standards of fast-track surgery and current postoperative management, the NGT should be removed as soon as possible after pancreatic resection. In some centers, the NGT is removed at the time the patient is extubated. Therefore, any nasogastric intubation lasting >3 postoperative days should be considered as DGE or a prolongation of DGE. In view of current practice, definitions from the early 1990s, in which maintenance of nasogastric intubation for >10 postoperative days was considered a sign of DGE, should be considered outdated. Therefore, need for maintenance of NGT for >3 days or the need to reinsert the NGT for persistent vomiting after POD 3 should be considered DGE.

Oral intake: The ability to tolerate a solid diet is an unequivocal goal in the postoperative management of patients undergoing pancreatic resections. A liquid diet is often offered to the patients starting on POD 1 or on the first day after removing the NGT. According to the published clinical pathways, a solid diet should be able to be given at the latest on POD 7 to allow early discharge of patients after pancreatic surgery. Therefore, the inability to tolerate a solid diet by POD 7 should be considered DGE.

Delayed gastric emptying: Several groups have proposed 2 widely used definitions for DGE after pancreatic resection. Yeo et al²⁹ defined DGE as a NGT left in place for ≥ 10 days plus one of the following or for <10 days plus 2 of the following: (a) repeated emesis after removal of the NGT, (b) need for prokinetic agents after POD 10, (c) need for reinsertion of the NGT, or (d) failure to progress with the diet. Similarly, van Berge Henegouwen et al³⁸ defined DGE as gastric stasis requiring nasogastric intubation for ≥ 10 days or the inability to tolerate a regular diet after POD 14. Other definitions only focus on the ability to tolerate oral intake after POD 7 or 14.^{18,41,67}

Consensus definition of delayed gastric emptying after pancreatic surgery. To evaluate the occurrence of DGE, many surgeons believe it is necessary

Table II. Consensus definition of DGE after pancreatic surgery

<i>DGE grade</i>	<i>NGT required</i>	<i>Unable to tolerate solid oral intake by POD</i>	<i>Vomiting/gastric distension</i>	<i>Use of prokinetics</i>
A	4–7 days or reinsertion > POD 3	7	±	±
B	8–14 days or reinsertion > POD 7	14	+	+
C	>14 days or reinsertion > POD 14	21	+	+

DGE, Delayed gastric emptying; *POD*, Postoperative day, *NGT*, Nasogastric tube.

To exclude mechanical causes of abnormal gastric emptying, the patency of either the gastrojejunostomy or the duodenojejunostomy should be confirmed by endoscopy or upper gastrointestinal gastrographin series.

to prove the patency of either the gastrojejunostomy or the duodenojejunostomy (depending on the reconstruction method used) by upper gastrointestinal contrast series or endoscopy and to exclude a small bowel obstruction close to the gastrojejunostomy or duodenojejunostomy. Occasionally a technical problem at the anastomosis, for example, a stenosis or other mechanical causes of abnormal gastric emptying, can lead to complete obstruction, which should not be classified as DGE.

The mild, moderate, and severe forms of DGE after pancreatic resection can be classified into grades A, B, and C by their clinical impact. Grade A DGE should be considered if the NGT is required between the POD 4 and 7, or if reinsertion of the NGT was necessary owing to nausea and vomiting after removal by POD 3 and the patient is unable to tolerate a solid diet on POD 7, but resumes a solid diet before POD 14. Grade B DGE is present if the NGT is required from POD 8–14, if reinsertion of the NGT was necessary after POD 7, or if the patient cannot tolerate unlimited oral intake by POD 14, but is able to resume a solid oral diet before POD 21. Grade C DGE is present when nasogastric intubation cannot be discontinued or has to be reinserted after POD 14, or if the patient is unable to maintain unlimited oral intake by POD 21.

In DGE grade A, vomiting is uncommon, whereas in DGE grades B and C, there is usually vomiting, perhaps indicating consideration of a trial of prokinetic drugs (such as metoclopramide or erythromycin) as used in idiopathic or diabetic gastroparesis.^{68,69} In DGE grade A, nutritional support (enteral or parenteral) might or might not be required in the first 14 postoperative days; in contrast, nutritional support is required in DGE grade B in the first 3 weeks postoperatively, whereas in DGE grade C, prolonged nutritional support for >3 weeks postoperatively is required. In DGE grade C, the institution of adjuvant therapy is delayed (Table II).

DGE grade A usually does not lead to a marked change in management other than by minor disturbances in the return to intake of solid food. For

DGE grade B, however, treatment with prokinetic drugs and parenteral or enteral nutritional support is necessary, sometimes leading to the need for reinsertion of the NGT. Therefore, DGE grade B prolongs the postoperative hospital stay and impairs the comfort and quality of life of the patient. Patients with DGE grade C require some form of nutritional support. As in some patients with DGE grade B, DGE grade C might often be associated with other postoperative complications, such as pancreatic fistula or intraabdominal abscess. Thus, further evaluation of patients with DGE grades B and C with radiologic imaging or on occasion relaparotomy may be necessary. DGE grade C prolongs hospital stay, leads to substantial discomfort for the patient, and is associated with an increased risk of other complications.

Based on these considerations, DGE was graded as follows (Table III). DGE grade A results in only a transient variation in the standard postoperative course of patients after pancreatic surgery, has no major clinical impact, and leads only to a slight deviation of the clinical pathway. DGE grade A is not associated with a major delay in the patient's hospital discharge. DGE grade B results in an adjustment of a given clinical pathway, including potential administration of prokinetic drugs and nutritional support. DGE grade B prolongs the patient's hospital stay. DGE grade C necessitates a major change in clinical management, requiring parenteral or enteral nutritional support and possibly treatment of associated postoperative complications, such as pancreatic fistula or intraabdominal abscesses. Consequently, further diagnostic workup and radiologic or operative interventions are often needed. The hospital stay of this group of patients is prolonged and any planned adjuvant therapy is delayed.

DISCUSSION

The causes for DGE are still often unclear and are probably multifactorial.^{18,25,28,70-72} Potential explanations for DGE after resective pancreatic surgery, especially pancreatoduodenectomy, include

Table III. Parameters for grading of DGE

<i>DGE</i>	<i>Grade A</i>	<i>Grade B</i>	<i>Grade C</i>
Clinical condition	Well	Often well/minor discomfort	Ill/bad/severe discomfort (increased overall risk owing to complications and procedures)
Comorbidities	No	Possibly yes (pancreatic leak or fistula, intraabdominal abscess)	Possibly yes (pancreatic leak or fistula, intraabdominal abscess)
Specific treatment	Possibly yes (prokinetic drugs)	Yes (prokinetic drugs, potential reinsertion of NGT)	Yes (prokinetic drugs, NGT)
Nutritional support (enteral or parenteral)	Possibly yes (slower return to solid food intake)	Yes (partial parenteral nutrition)	Yes (total parenteral or enteral nutrition via NGT, prolonged, i.e., >3 weeks postoperatively)
Diagnostic evaluation	No	Possibly yes (endoscopy, upper GI contrast study, CT)	Yes (endoscopy, upper GI contrast study, CT)
Interventional treatment	No	No	Possibly yes (e.g., abscess drainage, relaparotomy for complication, relaparotomy for DGE)
Prolongation of hospital stay	Possibly yes	Yes	Yes
Delay of potential adjuvant therapy	No	No	Yes

CT, Computed tomography; *DGE*, Delayed gastric emptying; *GI*, Gastrointestinal; *NGT*, nasogastric tube.

decreased plasma motilin concentrations caused by resection of the duodenum, extended lymph node dissection along the common hepatic artery with disruption of vagal and sympathetic innervation to the antropyloric regions, relative devascularization or denervation of the pylorus after pylorus-preserving pancreatoduodenectomy, anastomotic disruptions at the pancreaticojejunostomy, and transient pancreatitis.

Several important variables have contributed to the lack of a generally accepted definition of DGE. Reported series of patients undergoing pancreatic surgery differ considerably with regard to age, gender, and in particular, benign or malignant lesions as the reason for pancreatic resection. In addition, multiple operative techniques have been used for performing pancreatoduodenectomy, the most common pancreatic procedure leading to DGE. Major anatomic variations in the method of reconstruction, such as the length of the remnant duodenum, the extent of gastrectomy, antecolic or retrocolic gastrojejunostomy or duodenojejunostomy, and the presence or absence of a vagotomy, have all been suggested to impact on the occurrence of DGE.

In one report, the rate of DGE decreased from 17% to 6% over a 10-year period.⁴¹ The authors attributed this decrease in DGE to greater expertise and decreasing use of pylorus-preserving pancreatoduodenectomy. Apart from pancreatic fistula, occurrence of DGE was an independent predictor of the duration of hospital stay after pancreatoduodenectomy; hospital stay decreased from a median of 14 to 8 days over the 10-year period.

Recently, Kurosaki and Hatakeyama⁵¹ compared 3 existing definitions of DGE in a series of 55 consecutive patients undergoing pylorus-preserving pancreatoduodenectomy. Using the definitions of Fabre et al,⁵⁶ van Berge Henegouwen et al,³⁸ and Yeo et al,²⁹ they showed that the presence of DGE by these different definitions was 6%, 29%, and 18%, respectively, exemplifying again the need for objective, universally accepted consensus definitions of morbidity after pancreatic surgery. The lack of an accepted definition of DGE, coupled with a paucity of evidence-based approaches to management and without widely accepted rules for when to remove the NGT, makes the comparison of various studies of DGE in pancreatic surgery impossible.

Recently, a consensus definition of postoperative pancreatic fistula¹² and postpancreatectomy hemorrhage¹³ have been proposed by the International Study Group of Pancreatic Surgery (ISGPS); recently, the fistula definition has been validated.⁷³ Accordingly, the present definition of DGE should be validated as well by external, high-volume centers of pancreatic surgery to underscore its clinical relevance. The proposed definitions of the major complications after pancreatic resection should allow for a more valid comparison of future clinical trials in pancreatic surgery.

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