Systematic review

Systematic review of five feeding routes after pancreatoduodenectomy

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Background: **Current European guidelines recommend routine enteral feeding after pancreatoduodenectomy (PD), whereas American guidelines do not. The aim of this study was to determine the optimal feeding route after PD.**

Methods: **A systematic search was performed in PubMed, Embase and the Cochrane Library. Included were studies on feeding routes after PD that reported length of hospital stay (primary outcome).**

Results: **Of 442 articles screened, 15 studies with 3474 patients were included. Data on five feeding routes were extracted: oral diet (2210 patients), enteral nutrition via either a nasojejunal tube (NJT, 165), gastrojejunostomy tube (GJT, 52) or jejunostomy tube (JT, 623), and total parenteral nutrition (TPN, 424). Mean(s.d.) length of hospital stay was shortest in the oral diet and GJT groups (15(14) and 15(11) days respectively), followed by 19(12) days in the JT, 20(15) days in the TPN and 25(11) days in the NJT group. Normal oral intake was established most quickly in the oral diet group (mean 6(5) days), followed by 8(9) days in the NJT group. The incidence of delayed gastric emptying varied from 6 per cent (3 of 52 patients) in the GJT group to 23·2 per cent (43 of 185) in the JT group, but definitions varied widely. The overall morbidity rate ranged from 43·8 per cent (81 of 185) in the JT group to 75 per cent (24 of 32) in the GJT group. The overall mortality rate ranged from 1·8 per cent (3 of 165) in the NJT group to 5·4 per cent (23 of 424) in the TPN group.**

Conclusion: **There is no evidence to support routine enteral or parenteral feeding after PD. An oral diet may be considered as the preferred routine feeding strategy after PD.**

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Introduction

Pancreatoduodenectomy (PD) is the treatment of choice for resectable (pre)malignant neoplasms of the pancreatic head, ampulla, distal bile duct and duodenum[1]. PD is associated with a relatively high morbidity rate, including a high incidence of delayed gastric emptying that may interfere with the resumption of a normal diet[2–4]. Several enteral and parenteral feeding strategies have been investigated to cope with this problem. It has been suggested that routine early enteral tube feeding is not indicated after surgery for upper gastrointestinal malignancies[5,6]. In contrast, several studies have advocated the routine use of tube feeding in these patients as it might reduce infection rates and length of hospital stay[7–11]. This difference of opinion is also evident in current nutritional guidelines. The current guidelines of the European Society for Parenteral and Enteral Nutrition recommend routine use of early enteral nutrition in patients undergoing major gastrointestinal surgery for cancer, including PD[12]. In contrast, the current American Society for Parenteral and Enteral Nutrition guidelines recommend postoperative

nutritional support only in patients who are unlikely to meet their nutrient needs orally for a period of 7–10 days, which is not necessarily the case after PD[13]. Both of these guidelines are, however, based on limited studies in patients with gastrointestinal cancer, mainly colorectal and gastric, which might hamper the compliance of clinicians with these recommendations.

There is a lack of specific evidence concerning the optimal feeding strategy after PD. One systematic review previously addressed the role of routine enteral and parenteral nutrition after PD[14]. This 5-year-old review did not differentiate between the various enteral feeding routes, assess their associated complications or examine the methodological quality of the included studies. Moreover, several new studies have been published since then that have investigated the role of fast-track (enhanced recovery after surgery) oral diet strategies. The present systematic review of the literature compared outcomes of feeding an oral diet and enteral and parenteral feeding routes after PD, focusing on both efficacy and safety.

Methods

Study selection

A systematic literature search was performed in PubMed, Embase and the Cochrane Library for studies published to 26 April 2011. This study was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines[15]. Search terms used were 'PPPD or pancreaticoduodenectomy or pancreatoduodenectomy or pancreatic resection or pancreatectomy or Whipple' and 'nutrition or feeding or nasogastric or nasojejunal or jejunostomy', restricted to title, abstract and keywords. Titles and abstracts, and subsequently full-text articles, were screened independently by two authors based on inclusion and exclusion criteria. Disagreement on eligibility was addressed by discussion and consensus. Reference lists of all included papers and PubMed 'related articles' were searched manually to identify initially missed but relevant studies.

Eligibility criteria

Included were studies concerning feeding after PD (both pylorus-preserving PD and classical Whipple), reporting on length of hospital stay (primary outcome), with the full text available in English. Excluded were: review articles, opinion papers, case reports, animal studies and studies not reporting results of different routes separately. For some studies, certain investigated groups were excluded: those with combined feeding routes, unclear definitions of feeding protocols or any supplements in addition to the standard formula. If multiple series with overlapping cohorts were available from one centre, only the most recent study was included. Results of two variations within one feeding route (for example cyclic *versus* continuous jejunostomy feeding) were combined.

Assessment of methodological quality

The methodological quality of the studies was assessed independently by two authors. All studies were graded according to the Oxford Centre for Evidence-Based Medicine (CEBM) levels of evidence[16]. Because both randomized and cohort studies were included, it was not possible to apply a classical bias risk assessment method for the included articles. The risk of bias was therefore assessed using a standardized list of ten potential risks of bias, based on the Oxford CEBM Critical Appraisal Skills Programme appraisal sheets for randomized controlled trials and cohort studies[17–19].

Data extraction

Study characteristics, including sample size, study design, study interval, study population, and type and route of nutritional support, were obtained from the included studies. Where available, the following data were extracted from the included studies: length of hospital stay, time to resumption of normal diet, duration of (par)enteral nutrition, overall morbidity, incidence of delayed gastric emptying (International Study Group of Pancreatic Surgery (ISGPS) grade B/C[20] or similar) and postoperative pancreatic fistula (International Study Group on Pancreatic Fistula (ISGPF) grade B/C[21] or similar), tube-related complications and mortality. First authors of included papers were contacted if data were missing.

Statistical analysis

Mean(s.d.) or median (range) values were extracted from articles or obtained from the study authors if necessary. Weighted mean(s.d.) values were calculated using the mean(s.d.) values reported in the individual studies, or those derived from median (range) values using the methods described by Hozo and colleagues[22]. Total overall morbidity and mortality rates, and incidence of delayed gastric emptying and postoperative pancreatic fistula, were calculated.

A sensitivity analysis was performed to assess the impact of methodological quality on the primary outcome (length of hospital stay). Analysis for the primary endpoint was

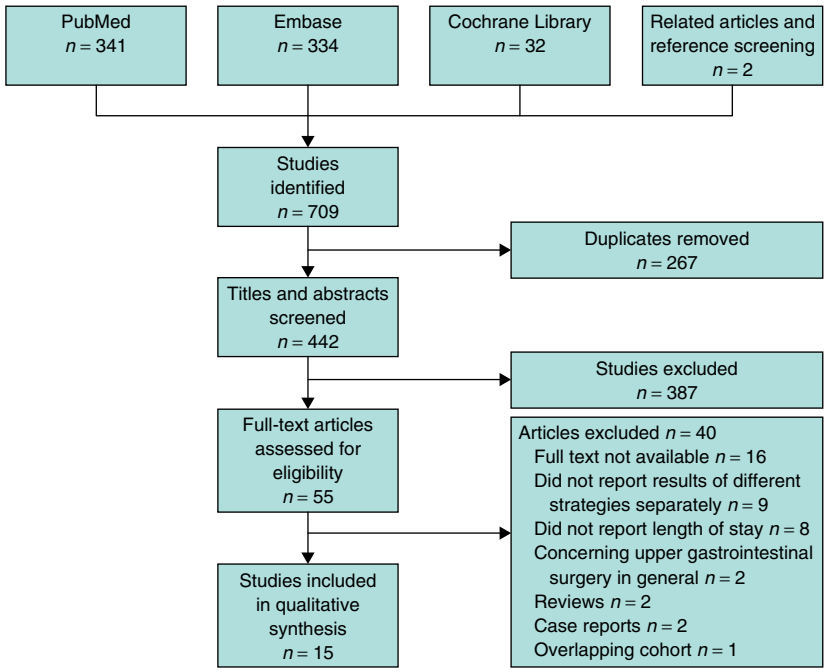

Fig. 1 Selection of articles for review

repeated using data only from studies of the highest quality, defined as both a level of evidence of 1, 2 or 3 and a maximum of one item (of 10) suggestive of risk of bias. A sensitivity analysis was also carried out to assess the impact of a fast-track strategy on the outcome of oral diet after PD. This involved analysis of the primary endpoint only in studies (or groups within studies) that did not use a fast-track strategy.

Results

The literature search and selection of articles for review is summarized in *Fig. 1*. Characteristics of the 15 included studies (7 randomized trials, 7 cohort studies and 1 case–control study) are shown in *Table 1*[23–37]. Formal meta-analysis was not performed because of the obvious heterogeneity between studies.

Eventually, data on five feeding routes were extracted: oral diet (2210 patients), enteral nutrition via either nasojejunal tube (NJT, 165), gastrojejunostomy tube (GJT, 52) or jejunostomy tube (JT, 623), and total parenteral nutrition (TPN, 424).

Five of the seven randomized clinical trials were designed to investigate the additional value of an adaptation to one of the feeding strategies, such as addition of a supplement (for example glutamine, synbiotics) to the standard formula or cyclic *versus* continuous enteral feeding[24,25,29,32,34]. Only two studies randomized between two different feeding routes; Mack and co-workers[28] randomized patients at the time of PD to GJT feeding or to an oral diet, whereas Brennan and colleagues[23] randomized between TPN and no TPN. Of the eight studies that included an oral diet group, three were designed to investigate the role of a fast-track protocol (generally fluids on day 1 after surgery and solid foods from day 2)[30,31,33]; in the other five, oral diet served as a control[23,26–28,36].

Methodological quality

Details of the methodological quality of the included studies are shown in *Table 2*. None of the randomized clinical trials, except those investigating a supplement to the standard formula, blinded participants or study personnel, because it was considered practically impossible. Confounding by indication was a common risk of bias in most cohort studies because the chosen feeding strategy was determined by surgeon's preference, which had not been accounted for in further analysis.

Primary outcome

Mean length of hospital stay was shortest in the oral diet and GJT groups, at 15(14) and 15(11) days respectively, followed by 19(12) days in the JT, 20(15) days in the TPN and 25(11) days in the NJT group (*Table 3*).

Table 1 Study characteristics

Reference	Year	Country	Study design	Sample size	Study interval (years)	Study population	Investigated groups
Brennan *et al.*[23]	1994	USA	RCT	117	5·5	Major pancreatic resection (including 97% PD)	TPN No nutritional support
Van Berge Henegouwen *et al.*[24]	1997	The Netherlands	RCT	57	1·3	Pylorus-preserving PD	Jejunostomy tube cyclic† Jejunostomy tube continuous†
Gianotti *et al.*[25]	2000	Italy	RCT	212	NR	PD for lesion of either pancreatic head or periampullary region	TPN Jejunostomy tube with standard formula Jejunostomy tube with immunonutrition*
Martignoni *et al.*[26]	2000	Switzerland	Retrospective cohort	62	2·5	PD	Jejunostomy tube No enteral feeding
Baradi *et al.*[27]	2004	USA	Retrospective cohort	180	7	PD	Enteral feeding (jejunostomy or gastrojejunostomy tube)* No enteral feeding
Mack *et al.*[28]	2004	USA	RCT	36	2·8	PD for periampullary tumour	Gastrojejunostomy tube Surgeon's routine
Jo *et al.*[29]	2006	South Korea	RCT	60	1	PD for periampullary tumour	TPN TPN with glutamine*
Berberat *et al.*[30]	2007	Germany	Retrospective cohort	255	1	Pancreatic resection in general (including 61% PD)	Fast-track oral diet
Kennedy *et al.*[31]	2007	USA	Retrospective cohort	135	2·8	PD	Prepathway oral diet* Critical pathway oral diet
Rayes *et al.*[32]	2007	Germany	RCT	80	NR	Pylorus-preserving PD	Nasojejunal tube with standard formula Nasojejunal tube with standard formula and synbiotics*
Balzano *et al.*[33]	2008	Italy	Retrospective cohort	504	8	PD	Traditional oral routine† Fast-track oral diet†
Hallay *et al.*[34]	2008	Hungary	RCT	22	3·5	Resection of head of pancreas because of cancer	TPN TPN and nasojejunal tube*
Akizuki *et al.*[35]	2009	Japan	Case–control	82	5	PD	Nasojejunal tube
Yermilov *et al.*[36]	2009	USA	Retrospective cohort	1873	10	PD for adenocarcinoma of pancreas	No nutritional support TPN Jejunostomy tube
Abu Hilal *et al.*[37]	2010	UK	Retrospective cohort	100	1·5	Pancreatic resection in general (including 93% PD)	Jejunostomy tube Gastrojejunostomy tube Nasojejunal tube

*Excluded from the analysis; †results combined for analysis. RCT, randomized clinical trial; PD, pancreatoduodenectomy; TPN, total parenteral nutrition; NR, not reported.

Secondary outcomes

Resumption of normal diet was reported in seven studies (*Table 4*). It was established most quickly in the oral diet group, after a mean duration of 6(5) days, followed by 8(9) days in the NJT, 11(5) days in the TPN, 12(11) days in the JT and 14(8) days in the GJT group.

Duration of artificial feeding was reported in seven studies. The mean duration of enteral nutrition was 9(8) days in the NJT, 12(7) in the JT and 10(8) days in the GJT group. Mean duration of parenteral nutrition was 13(6) days in the TPN group. Some 29·4 per cent of patients (55 of 187) in the oral diet group received parenteral nutrition at some point during their hospital stay, for a mean duration of 7(11) days, owing to complications such as delayed gastric emptying. One study reported that TPN was started immediately after surgery because of preoperative weight loss or malnutrition in six of 16 patients[28]. As the basic feeding strategy in this group was an oral diet, these patients were included in the oral diet group according to the intention-to-treat principle.

Table 2 Assessment of methodological quality

Reference	Level of evidence	Random allocation	Blinding	Intention-to-treat analysis	Same treatment, follow-up and data collection	Similar groups	Follow-up	Recruiting/selection bias	Classification bias	Measurement bias	Confounding by indication
Brennan *et al.*[23]	2	○	□	●	●	●	●	–	–	–	–
Van Berge Henegouwen *et al.*[24]	3	○	□	●	●	●	●	–	–	–	–
Gianotti *et al.*[25]	3	●	□	○	●	●	●	–	–	–	–
Martignoni *et al.*[26]	3	–	–	–	–	●	●	●	●	●	□
Baradi *et al.*[27]	3	–	–	–	–	□	●	●	●	●	□
Mack *et al.*[28]	2	●	□	●	●	●	●	–	–	–	–
Jo *et al.*[29]	3	●	●	○	●	●	●	–	–	–	–
Berberat *et al.*[30]	4	–	–	–	–	–	●	–	–	–	–
Kennedy *et al.*[31]	3	–	–	–	–	●	●	□	●	□	●
Rayes *et al.*[32]	3	●	●	●	●	●	●	–	–	–	–
Balzano *et al.*[33]	3	–	–	–	–	●	●	□	●	●	●
Hallay *et al.*[34]	3	□	□	○	●	○	●	–	–	–	–
Akizuki *et al.*[35]	4	–	–	–	–	–	●	–	–	–	–
Yermilov *et al.*[36]	3	–	–	–	–	□	□	●	□	●	●
Abu Hilal *et al.*[37]	3	–	–	–	–	●	●	●	●	●	□

●, Consistent with criteria, low risk of bias; ○, partly consistent with criteria, unknown risk of bias; □, not consistent with criteria, high risk of bias; –, not applicable.

Table 3 Length of hospital stay

Reference	Length of hospital stay (days)					*P*
	Oral diet	Nasojejunal tube	Gastrojejunostomy tube	Jejunostomy tube	TPN	
Brennan *et al.*[23]	14 (6–88)*	–	–	–	16 (7–72)*	NR
Van Berge Henegouwen *et al.*[24]	–	–	–	16 (9–73)*	–	
Gianotti *et al.*[25]	–	–	–	17·0(6·1)	18·8(6·4)	NR
Martignoni *et al.*[26]	15 (9–56)*	–	–	23 (13–74)*	–	< 0·01
Baradi *et al.*[27]	14·8(8·8)	–	–	–	–	
Mack *et al.*[28]	15·8(7·8)	–	11·5(2·9)	–	–	0·01
Jo *et al.*[29]	–	–	–	–	14·5 (9–41)*	
Berberat *et al.*[30]	10 (4–115)*	–	–	–	–	
Kennedy *et al.*[31]	7 (NR)*	–	–	–	–	
Rayes *et al.*[32]	–	22(16)	–	–	–	
Balzano *et al.*[33]	14 (7–110)*	–	–	–	–	
Hallay *et al.*[34]	–	–	–	–	17 (9–24)*	
Akizuki *et al.*[35]	–	32 (19–93)*	–	–	–	
Yermilov *et al.*[36]	16·4(10·8)	–	–	18·7(12·5)	22·5(16·6)	NR
Abu Hilal *et al.*[37]	–	15 (8–60)*	17 (8–64)*	16 (10–55)*	–	0·353
Overall	15(14)	25(11)	15(11)	19(12)	20(15)	

Values are mean(s.d.) unless indicated otherwise; *values are median (range). TPN, total parenteral nutrition; NR, not reported.

Overall morbidity was lowest in the JT group with a mean rate of 43·8 per cent (81 of 185 patients), followed by 49·4 per cent (310 of 627) in the oral diet, 50 per cent (48 of 96 patients) in the TPN, 56 per cent (24 of 43) in the NJT and 75 per cent (24 of 32) in the GJT group. Most studies distinguished between early *versus* late, minor *versus* major or infectious *versus* non-infectious complications, without reporting overall numbers.

The mean incidence of delayed gastric emptying varied from 6 per cent (3 of 52 patients) in the GJT group to 23·2 per cent (43 of 185) in the JT group (*Table 5*). The incidence in the oral diet group was 14·1 per cent (135 of 955). Definitions varied widely, with only one study[35] using the ISGPS definition. The same applied to postoperative pancreatic fistula[33]. The mean incidence of pancreatic fistula varied from 4 per cent (2 of 52 patients)

Table 4 Time to resumption of normal diet

Reference	Definition	Time to resumption of normal diet (days)					*P*
		Oral diet	Nasojejunal tube	Gastrojejunostomy tube	Jejunostomy tube	TPN	
Van Berge Henegouwen *et al.*[24]	First day of normal diet	–	–	–	10 (5–68)*	–	
Gianotti *et al.*[25]	First day of solid diet	–	–	–	9·8(3·8)	10·4(3·7)	NR
Baradi *et al.*[27]	Time when regular diet was started	10·5(7·7)	–	–	–	–	
Jo *et al.*[29]	Time to soft diet	–	–	–	–	11·5(7·4)	
Berberat *et al.*[30]	Return to normal food	5 (1–24)*	–	–	–	–	
Akizuki *et al.*[35]	Start of solid diet	–	7 (4–39)*	–	–	–	
Abu Hilal *et al.*[37]	Resumption of normal diet	–	10 (5–39)*	14 (7–37)*	14 (6–53)	–	0·018
Overall		6(5)	8(9)	14(8)	12(11)	11(5)	

Values are mean(s.d.) unless indicated otherwise; *values are median (range). TPN, total parenteral nutrition; NR, not reported.

Table 5 Delayed gastric emptying

Reference	Definition	Delayed gastric emptying					*P*
		Oral diet	Nasojejunal tube	Gastrojejunostomy tube	Jejunostomy tube	TPN	
Brennan *et al.*[23]	Nasogastric tube drainage of > 500 ml on POD 6	1 of 57	–	–	–	2 of 60	0·38
Van Berge Henegouwen *et al.*[24]	Gastric stasis, requiring nasogastric intubation for ≥ 10 days, or inability to tolerate a regular diet on or after POD 14	–		–	14 of 57	–	
Gianotti *et al.*[25]	NR	–	–	–	9 of 73	10 of 68	
Martignoni *et al.*[26]	Nasogastric tube for > 10 days postop., vomiting > 3 consecutive days after POD 5 and if X-ray with water-soluble contrast medium revealed hold-up of contrast medium in stomach	5 of 32	–	–	17 of 30	–	0·01
Mack *et al.*[28]	Inability to tolerate oral intake on or after POD 14	4 of 16	–	0 of 20	–	–	0·03
Jo *et al.*[29]	Inability to tolerate a regular or normal diet by POD 14, or gastric stasis that required nasogastric decompression for ≥ 7 days at any time	–	–	–	–	4 of 28	
Berberat *et al.*[30]	Need to leave nasogastric tube in place for > 10 days or reinsertion after POD 10	20 of 255	–	–	–	–	
Kennedy *et al.*[31]	Persistent vomiting or inability to tolerate diet requiring replacement of nasogastric tube	8 of 91	–	–	–	–	
Rayes *et al.*[32]	NR	–	4 of 40	–	–	–	
Balzano *et al.*[33]	Need for nasogastric decompression or vomiting after POD 10	97 of 504	–	–	–	–	
Akizuki *et al.*[35]	Grade B or C according to ISGPS	–	19 of 82	–	–	–	
Abu Hilal *et al.*[37]	NR	–	5 of 43	3 of 32	3 of 25	–	0·937
Overall		135 of 955 (14·1)	28 of 165 (17·0)	3 of 52 (6)	43 of 185 (23·2)	16 of 156 (10·3)	

Values in parentheses are percentages. TPN, total parenteral nutrition; POD, postoperative day; NR, not reported; ISGPS, International Study Group of Pancreatic Surgery.

Table 6 Postoperative pancreatic fistula

Reference	Definition	Postoperative pancreatic fistula					*P*
		Oral diet	Nasojejunal tube	Gastrojejunostomy tube	Jejunostomy tube	TPN	
Brennan *et al*.[23]	NR	5 of 57	–	–	–	8 of 60	0·62
Van Berge Henegouwen *et al*.[24]	NR	–	–	–	4 of 57	–	
Gianotti *et al*.[25]	Sterile pancreatic fistula	–	–	–	9 of 73	8 of 68	NR
Baradi *et al*.[27]	Late pancreatic fistula (after POD 30)	0 of 82	–	–	–	–	
Mack *et al*.[28]	Radiographically detected leak, or drainage > 50 ml on or after POD 10	1 of 16	–	1 of 20	–	–	NR
Jo *et al*.[29]	Amylase and lipase in drain fluid ≥ 3 times normal upper limits of serum level, drainage sustained after POD 7, and drainage fluid ≥ 10 ml/day	–	–	–	–	0 of 28	
Berberat *et al*.[30]	Persisting secretions of > 30 ml/day amylase-rich fluid (> 5000 units/ml) for > 10 days postop., or recurrence of amylase-rich fluid in an intra-abdominal abscess	4 of 255	–	–	–	–	
Kennedy *et al*.[31]	Output of > 30 ml/day amylase-rich fluid (> 3 times serum value) for > 10 days postop.	2 of 91	–	–	–	–	
Rayes *et al*.[32]	NR	–	4 of 40	–	–	–	
Balzano *et al*.[33]	Grade B or C according to ISGPF	65 of 504	–	–	–	–	
Akizuki *et al*.[35]	NR	–	13 of 82	–	–	–	
Abu Hilal *et al*.[37]	NR	–	0 of 43	1 of 32	1 of 25	–	0·451
Overall		77 of 1005 (7·7)	17 of 165 (10·3)	2 of 52 (4)	14 of 155 (9·0)	16 of 156 (10·3)	

Values in parentheses are percentages. TPN, total parenteral nutrition; NR, not reported; POD, postoperative day; ISGPF, International Study Group on Pancreatic Fistula.

in the GJT group, to 10·3 per cent in the NJT and TPN groups (17 of 165 and 16 of 156 patients respectively) (*Table 6*).

Mortality rates ranged from 1·8 per cent (3 of 165 patients) in the NJT group to 2 per cent (1 of 52) in the GJT, 4·4 per cent (96 of 2178) in the oral diet, 4·7 per cent (28 of 593) in the JT and 5·4 per cent (23 of 424) in the TPN group.

Safety

Tube-related complications were addressed in only two studies, including a total of 241 patients[25,37]. The incidence varied from 12 per cent (5 of 43 patients) in the NJT group, caused mainly by blockage and dislodgement, to 14 per cent (14 of 98) in the JT group, mainly due to blockage, and 34 per cent (11 of 32) in the GJT group, owing to blockage and peritonitis after removal. Increased infection rates in the TPN group were reported by both studies that compared complication rates between TPN and oral diet or enteral nutrition groups[23,25]. One study also reported specific TPN-related metabolic complications, which were present in two of 60 patients[23]. No complications specifically related to an oral diet were reported in the included studies. One study reported a higher incidence of vomiting in the oral diet group than with enteral tube feeding: 29 per cent (24 of 82) *versus* 10 per cent (10 of 98)[27]. In one study that reported on weight loss during the hospital stay, there was no difference between the oral diet and enteral nutrition groups (mean 3·8 *versus* 4·4 kg)[26].

Sensitivity analysis

No major changes in length of hospital stay were found when the analysis was restricted to studies of higher quality (those with the lowest risk of bias)[23–26,28,29,32,33,37]. In the oral diet group, length of hospital stay decreased from 15

to 14 days; hospital stay was also reduced in the NJT and TPN groups (to 18 and 17 days respectively).

Sensitivity analysis demonstrated that a fast-track strategy had no major impact on the primary endpoint[23,26–28,33,36]. The length of hospital stay in the oral diet group increased from 15 to 16 days when the analysis was restricted to studies (or groups within studies) that did not use a fast-track strategy.

Discussion

This systematic review has compared the outcomes of the five most frequently used feeding routes after PD, and analysed methodological quality and feeding-related complications. No major differences in outcomes were detected between an oral diet, enteral nutrition via either a NJT, JGT or DT, and TPN after PD. As several relevant outcomes (length of hospital stay, time to resumption of normal diet) appeared to be most favourable (or at least not inferior) in the oral diet group, oral feeding may be considered as the preferred strategy after PD.

Although few studies reported on feeding-related complications after PD, these complications have been described in the general feeding literature. NJTs dislodge in up to 36 per cent patients within the first week[38–42]. Percutaneous JTs can cause potentially life-threatening torsion and bowel necrosis in 0·4 per cent of patients[43]. TPN is associated with a well documented increased risk of infection[44]. Although data are scarce, an oral diet strategy does not seem to be associated with such risks, as confirmed in the present study.

It should be noted that the oral feeding protocols of the studies in this review varied considerably. Several studies included a fast-track (enhanced recovery) programme[30,31,33], whereas others described the oral diet strategy as 'no nutritional support/enteral feeding', without providing clear specifications[23,26–28,36]. The fast-track regimens consisted of an early start (within 24 h) and stepwise increase in oral intake, but also a pain management protocol, early mobilization and routine pharmacological support for early gastrointestinal function. In two studies that compared such fast-track regimens with more traditional protocols, it was concluded that fast-track protocols resulted in a reduced incidence of delayed gastric emptying and shorter hospital stay, without increasing readmission rates, thereby decreasing costs and improving patient comfort[31,33]. The present analysis demonstrated that a fast-track strategy had only a minor (1 day) impact on hospital stay in the oral diet group. Nonetheless, an average of 29·4 per cent of patients fed orally required nutritional support, mainly because oral intake was insufficient or owing to complications such as pancreatic fistula. Characteristics of these patients were not specified separately.

In the present studies only sparse details on preoperative nutritional status were reported, making it difficult to evaluate its impact on decision-making and outcomes. Future prospective studies should aim at preoperative identification of those who are at high risk of requiring postoperative nutritional support. These patients could then receive preoperative nutritional support, as recommended by the current nutritional guidelines[12,13], and/or a NJT during surgery, thereby minimizing both malnutrition and patient discomfort. The potential effect of preoperative nutritional support is of course dependent on severity of jaundice and biliary drainage.

The present analysis differs considerably from the previous review on this topic[14] as the latter included only four of the 15 studies reviewed here. There are some limitations that must be taken into account. First, the quality of the included studies is moderate. Sensitivity analysis, however, revealed no impact of methodological quality on the primary outcome of this study. Second, of the seven randomized clinical trials, only two directly compared outcomes of two different feeding routes[23,28]. In addition, another three (of 8) non-randomized studies directly compared outcomes of two or three different feeding routes[26,36,37].

One could argue that the primary outcome measure of this study (length of hospital stay) is subject to the influence of several factors other than nutrition, such as differences in discharge policies between Western and Eastern countries, or the gradual reduction in length of stay associated with enhanced recovery programmes over the past few decades. For the latter, no such trend could be observed when comparing the oldest studies (length of stay 14–16 days)[23,24] with the most recent ones (15–32 days)[35,37]. In addition, length of stay was the most commonly reported outcome in the literature on this topic. Outcome measures that are more specifically related to feeding (such as time to resumption of normal oral diet, serum albumin levels or weight loss during hospital stay) were rarely reported.

Another limitation is that definitions of various endpoints varied widely among the studies. For example, only two studies[33,35] used the ISGPS or ISGPF definition of delayed gastric emptying or postoperative pancreatic fistula, known to result in a relatively high incidence of complications[3]. The definition of oral diet and regular standards of care also varied between studies. Finally, a subgroup analysis of the primary outcome in patients with delayed gastric emptying could not be performed, as the

included studies did not report outcomes for the subgroups of patients with and without delayed gastric emptying.

These shortcomings should be borne in mind when interpreting the results of this systematic review. This review summarized the available evidence on feeding routes after PD, including assessment of methodological quality, without an attempt at meta-analysis, as this would have been inappropriate given the heterogeneity in study designs and protocols.

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Commentary

Systematic review of five feeding routes after pancreatoduodenectomy (*Br J Surg* 2013; 100: 589-598)

Eating activates all digestive reflexes, probably stimulates gut motility, and is associated with pleasure and well-being. Eating is a volitional process that leaves the patient in control and it has never been shown to cause any harm.

Early food after surgery was ignored dogmatically throughout the 'enteral *versus* parenteral' controversy. In the clash of the two industrially sponsored titans, few paid notice to the qualities of food. And when the tide started to turn, misconceptions occurred. In a meta-analysis from 2001, little distinction was made between enteral feeding and eating[1]. To tube-feed the gut artificially was wrongly perceived as equal to eating and not as an extension of the nil-by-mouth dogma.

Against this background, this systematic review by Gerritsen and co-workers is welcome and it is reasonable to accept their careful conclusions, not because the background database is good – it is not – but because the conclusions dovetail with the development in other areas of major surgery and with data not included in the review. A randomized trial with 477 patients, including 82 subjected to pancreatoduodenectomy (PD), and comparing early food at will with enteral tube feeding, supports the present findings[2].

The authors compare studies where short length of stay was a primary target with studies where this was largely ignored. This is questionable. The difference between postoperative stays of 32 and 7 days is not due to different feeding strategies, but primarily related to tradition, organization and issues of reimbursement. This weakens the argument but should not alter the conclusion.

Timing of oral diet is not discussed in the present review and the nil-by-mouth dogma could be further dismantled; after PD, we should offer patients normal food at will from postoperative day 1, while informing them about the need for a careful and stepwise increase. This is supported by the available data and advocated by a recent international consensus[3].

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