Impact of routine nasogastric decompression versus no nasogastric decompression after pancreaticoduodenectomy on perioperative outcomes: meta-analysis

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Abstract

Background: Consensus on the use of nasogastric decompression (NGD) after pancreaticoduodenectomy (PD) is lacking. This meta-analysis reviewed current evidence on the impact of routine NGD versus no NGD after PD on perioperative outcomes.

Methods: PubMed, Medline, Scopus, Embase and Cochrane databases were searched for studies reporting on the role of NGD after PD on perioperative outcomes. Data up to January 2021 were retrieved and analysed.

Results: Eight studies were included, with a total of 1301 patients enrolled, of whom 668 had routine NGD. Routine NGD was associated with a higher incidence of overall delayed gastric emptying (DGE) (odds ratio (OR) 2.51, 95 per cent c.i. 1.12 to 5.63, I² = 83 per cent; P = 0.03) and clinically relevant DGE (OR 3.64, 95 per cent c.i. 1.83 to 7.25, I² = 54 per cent; P < 0.01), a higher rate of Clavien–Dindo grade II or higher complications (OR 3.12, 95 per cent c.i. 1.05 to 9.28, I² = 88 per cent; P = 0.04) and increased length of hospital stay (mean difference 2.67, 95 per cent c.i. 0.60 to 4.75, I² = 97 per cent; P = 0.02). There were no significant differences in overall complications (OR 1.07, 95 per cent c.i. 0.79 to 1.46, I² = 0 per cent; P = 0.66) or postoperative pancreatic fistula (OR 1.21, 95 per cent c.i. 0.86 to 1.72, I² = 0 per cent; P = 0.28) between patients with or those without routine NGD.

Conclusion: Routine NGD was associated with increased rates of DGE, major complications and longer length of stay after PD.

Introduction

Pancreaticoduodenectomy (PD) is the only curative treatment for periampullary, pancreatic, biliary tract and duodenal tumours. PD is associated with a high postoperative morbidity rate of between 30 and 50 per cent, despite major progress in operative techniques and perioperative care. Postoperative morbidity, in turn, influences the quality of life and particularly oncolgic outcomes due to delays in receiving adjuvant chemotherapy.

Postoperative management after PD often includes placement of a nasogastric (NG) tube for gastric decompression. NG tubes are traditionally placed with a view to divert gastric juices and manage postoperative ileus and delayed gastric emptying (DGE). It is also commonly perceived that routine nasogastric decompression (NGD) after major abdominal surgery accelerates gastrointestinal functional recovery and reduces anastomotic leaks, gastric stasis, nausea and vomiting. However, recent evidence suggests NGD may result in a delayed return of bowel function, higher pulmonary complication rates and a longer hospital stay. It is generally agreed that routine NGD should no longer be used after liver, oesophageal, gastric or colorectal surgeries. With regard to pancreatic surgery, the Enhanced Recovery After Surgery (ERAS) guidelines recommend against the routine use of NGD after PD. A recent single-centre RCT also found that there is no significant difference in the occurrence of Clavien–Dindo grade II or higher complications, DGE or length of hospital stay following routine NGD after PD. Therefore, a lack of consensus around the necessity of routine NG tube placement after PD, with previous systematic reviews limited to only retrospective and non-randomized studies.

Methods

The study was prospectively registered on PROSPERO (CRD42021230650).
Data sources and searches
This study was reported according to PRISMA criteria. PubMed, Medline, Scopus, Embase and Cochrane databases were searched for studies reporting the role of NG tube decompression after PD and perioperative outcomes up to January 2021. The following query terms were employed: the combined results of ‘pancreaticoduodenectomy’ OR ‘Whipple’ OR ‘pancreatic surgery’ AND the combined results of ‘gastric decompression’ OR ‘nasogastric decompression’ or ‘nasogastric tube’ AND the combined results of ‘gastric stasis’ or ‘nasogastric tube decompression’ or ‘nasogastric tube’. There were no date or language restrictions. Two authors (K. A., V. P.) undertook the search independently and when there was a disagreement, the senior author was consulted (S. P.).

Study selection
Single and multicentre retrospective or prospective cohort studies and randomised controlled studies investigating the role of NG tube insertion after PD were included. Review articles, case reports, conference abstracts, letters and non-English articles were excluded. Studies comparing NGD to gastrostomy decompression were also excluded.

Definitions
DGE was defined and graded into three grades A, B and C, based on the International Study Group of Pancreas Surgery (ISGPS) classification. Grade A DGE was diagnosed if patients required an NG tube between postoperative days (PODs) 4 and 7 (including reinsertion after initial removal) or in those who failed to tolerate a solid diet by POD 7 but could tolerate a solid diet before POD 14. Grade B DGE was diagnosed in patients who required an NG tube from POD 8 to 14 (including reinsertion after initial removal) or in those not tolerating solid oral intake by POD 14 but could tolerate solid oral intake by POD 21. Grade C DGE was considered if patients required an NG tube after POD 14 (including reinsertion after initial removal) or in those who could not maintain solid oral intake by POD 21. Grade B and C DGE was considered clinically relevant DGE (CR-DGE).

POFF was defined and graded A, B or C according to the International Study Group on Pancreatic Fistula (ISGPF) definition in 2005. The definition and grading of POFF were updated in 2016, according to the ISGPF classification. Studies using either of these definitions were included in this review.

Outcome measures
The primary outcome measure was the effect of routine NGD versus no NGD on DGE and CR-DGE rate. The secondary outcome measures were overall complications, Clavien–Dindo grade 0–I and II or higher complications, POFF, POPF grades B/C, bile leak, time to tolerate oral fluid and solid intake, reinsertion of NG tube, length of hospital stay and mortality.

Data extraction and quality assessment
Three authors (K. A., V. P. and T. K.) extracted data from the included studies using predefined proformas. The quality of included studies was assessed using the ROBINS-I risk of bias in non-randomised studies of interventions and Cochrane Risk of Bias 2 tools to determine risk of bias in non-RCTs and RCTs, respectively.

Statistical methods
A random-effects, pairwise meta-analysis was conducted in R (R Foundation for Statistical Computing, Vienna, Austria) with the metafor package. The Mantel–Haenszel method was employed, and the DerSimonian–Laird estimator for between-study variance. Weighted means were calculated by the generic inverse variance method. Baseline differences were compared with a random-effects, pairwise meta-analysis; continuous baseline variables were reported as weighted means. Odds ratios were presented for dichotomous variables, and mean differences (MD) for continuous variables with 95 per cent confidence intervals. Statistical heterogeneity was indicated by the I² values whereby a threshold of 50 and 75 per cent were indicative of moderate and substantial heterogeneity, respectively. Publication bias was assessed by visual inspection of funnel plots. A sensitivity analysis was performed for primary outcomes after removal of the single RCT.

Results
Study and patient characteristics
Eight studies were included in the meta-analysis (Fig. 1), with a total of 1301 patients enrolled, of whom 668 had routine postoperative NGD. The study population’s baseline characteristics are summarised in Table 1. The male-to-female ratio was 660:640 (approximately 1:1). Studies were published between March 2011 and July 2020, and conducted in Norway, France, Korea and the United States. One study was an RCT, six were prospective comparative studies and one was a retrospective study. The study characteristics are summarized in Table 2. A total of 92.5 per cent of patients underwent PD and 7.5 per cent underwent either a distal or a total pancreatectomy. Amongst those patients who underwent PD, 50.1 per cent underwent a classic PD, and 49.9 per cent a pylorus-preserving PD.

Quality assessment and risk of bias
Risk of bias assessment for the single RCT by using the Cochrane Risk of Bias 2 tool showed a low risk of bias. The remaining non-RCTs showed a low risk of bias for three studies and a moderate risk of bias for four studies (Table S1).

Primary outcome measures
Definition of DGE
Six studies used the ISGPS definition of DGE, whereas two studies defined DGE differently. Choi et al. defined DGE as gastric stasis requiring an NG tube for more than 10 days or where a regular diet was not tolerable on POD 14. Roland et al. diagnosed DGE if an NG tube was reinserted because of nausea and vomiting for more than 7 days and not tolerating an oral diet or hydration by day 10 or inability to tolerate an oral diet prolonging hospital stay by more than 2 days.

DGE
All studies were included in the analysis of overall DGE, with a total of 668 patients with routine NGD and 633 patients without NGD associated with a higher rate of DGE: 29.3 per cent (196/668) versus 13.4 per cent (85/633) in those without NGD (odds ratio 2.51, 95 per cent c.i. 1.12 to 5.63, I² = 83 per cent; P = 0.03) (Fig. 2a).
DGE grades B and C (CR-DGE)
Six studies reported CR-DGE \(^\text{13,15,25,27–29}\), with a total of 494 patients in the NGD group and 535 patients in the no-NGD group. NGD was associated with a higher incidence of CR-DGE. The rate of CR-DGE in the NGD group was 16 per cent \((107/668)\), and 5.3 per cent \((34/663)\) in the no-NGD group \((\text{odds ratio } 3.64, 95\text{ per cent c.i. } 1.83 \text{ to } 7.25, I^2 = 54\text{ per cent; } P < 0.01)\) \((\text{Fig. 2b})\).

A sensitivity analysis was performed after removal of the RCT, which showed lower rates of DGE \((P = 0.03)\) and CR-DGE \((P < 0.01)\) in the no NGD group \((\text{Fig. S1})\).

Secondary outcome measures
All complications
There were no significant differences in the overall complications \((\text{odds ratio } 1.07, 95\text{ per cent c.i. } 0.79 \text{ to } 1.46, I^2 = 0\text{ per cent; } P = 0.66)\) \((\text{Fig. 2c})\). Similarly, there were no significant differences between the two groups in Clavien–Dindo grade 0–I complications \((\text{odds ratio } 0.59, 95\text{ per cent c.i. } 0.14 \text{ to } 2.49, I^2 = 89\text{ per cent; } P = 0.47)\) \((\text{Fig. 2d})\). Clavien–Dindo grade II or higher complications occurred more frequently with NGD \((\text{odds ratio } 3.12, 95\text{ per cent c.i. } 1.05 \text{ to } 9.28, I^2 = 88\text{ per cent; } P = 0.04)\) \((\text{Fig. 2e})\).

Postoperative pancreatic fistula and bile leak
POPF was defined in four studies \(^{24,25,27,28}\) according to the ISGPF 2005 classification\(^1\), whereas three studies \(^{13,13,29}\) used the updated classification \((\text{ISGPF 2016})\)\(^\text{19}\).

There were no significant differences in overall POPF \((\text{odds ratio } 1.21, 95\text{ per cent c.i. } 0.86 \text{ to } 1.72, I^2 = 0\text{ per cent; } P = 0.28)\) or clinically relevant POPF \((\text{grades B and C})\) \((\text{odds ratio } 1.16, 95\text{ per cent c.i. } 0.75 \text{ to } 1.78, I^2 = 0\text{ per cent; } P = 0.51)\) \((\text{Fig. 2f, g})\). Similarly, there were no significant differences in rates of bile leak \((\text{odds ratio } 1.21, 95\text{ per cent c.i. } 0.47 \text{ to } 3.14, I^2 = 0\text{ per cent; } P = 0.70)\) \((\text{Fig. 2h})\).
Pulmonary complications
There were no significant differences in pulmonary complications (odds ratio 2.05, 95 per cent c.i. 0.99 to 4.24, *P* = 0.05) (Fig. 3a).

Time to oral intake
There were no significant differences in time to first oral fluid (MD 1.44, 95 per cent c.i. −0.66 to 3.54, *I*² = 99 per cent; *P* = 0.13) or solid intake (MD 2.50, 95 per cent c.i. −0.78 to 4.89, *I*² = 99 per cent; *P* = 0.10) (Fig. 3b, c).

Reinsertion of NG tube
The rate of reinsertion of an NG tube after removal in the NGD group was 16 per cent, whereas 12.5 per cent of patients required NG tube reinsertion in the no-NGD group (odds ratio 0.82, 95 per cent c.i. 0.58 to 1.96, *I*² = 57 per cent; *P* = 0.82) (Fig. 3d).

Length of hospital stay
The mean length of hospital stay with NGD was 5.40 ± 6.03, whereas without NGD, the mean length of hospital stay was 5.00 ± 3.82 (MD 2.67, 95 per cent c.i. 0.60 to 4.75, *I*² = 97 per cent; *P* = 0.02) (Fig. 3e).

Mortality
There were no significant differences in 30-day (odds ratio 0.87, 95 per cent c.i. 0.2 to 3.74, *I*² = 20 per cent; *P* = 0.85) or 90-day mortality (odds ratio 1.47, 95 per cent c.i. 0.27 to 8.09, *I*² = 27 per cent; *P* = 0.66) between the two groups (Fig. 3f, g).

Publication bias
Funnel plots for publication bias are summarized in Figs S2–S7. There was no evidence of publication bias in overall complications, CR-DGE, POPF or mortality outcomes. There was publication bias in Clavien–Dindo grade 0–I and Clavien–Dindo grade II or higher complications, as well as in overall DGE, length of hospital stay and time to first oral fluid and solid intake.

Discussion
The present systematic review and meta-analysis assessed the impact of routine NGD after PD. Results showed that routine NGD was associated with higher rates of DGE, CR-DGE, increased Clavien–Dindo grade II or higher complications, increased pulmonary complications and a longer hospital stay.

Despite the declining practice of NGD after major abdominal surgeries, some ambiguity remains with regard to use of routine NGD after PD.5,8 This is largely due to a perceived increased risk of complications unique to PD such as DGE, POPF or biliary leakage. NGD is thought to decompress the stomach and reduce tension on the gastroenteric anastomosis, potentially leading to a decreased risk of anastomotic leaks and overall morbidity associated with PD. The ERAS 2019 recommendations to remove NG tubes before reversal of anaesthesia in PD have not been adopted by most surgeons, as the impact of removal of NG tubes on POPF and DGE rates was not clear.13,16,29,30 Moreover, the rate of reinsertion of NG tubes was not known. The majority of the studies on which the ERAS recommendations were based were retrospective in nature, included small sample sizes and were single-centre.13,16,29,30 DGE occurs in 10 to 45 per cent of patients after PD.31–34 Risk factors for DGE include POPF, postoperative complications and potentially reconstruction technique.35–37 The pathophysiology of DGE after PD remains poorly understood. Gastric accommodation, gastroduodenal pressure gradients and antro-pyloric coordination may be impaired after a classic Whipple’s, and these factors likely play an important role in DGE.38–40 It remains unclear if NGD is favourable for DGE in the context of altered

Table 1 Baseline characteristics of participants included in studies

| Study          | Study population | Sex M/F | Age (year) mean ± SD | Malignant/benign indication | Preoperative DM | Preoperative BMI | Whipple’s/PPPD | Blood loss (ml) mean ± SD |
|----------------|------------------|---------|----------------------|-----------------------------|----------------|-----------------|---------------|--------------------------|
|                | NGD*             | NGD     | NGD                  | NGD                         | NGD            | NGD             | NGD           | NGD                      |
|                | No NGD†          | No NGD  | No NGD               | No NGD                      | No NGD         | No NGD          | No NGD        | No NGD                    |
| Kleive13       | 31/14            | 69.4 ± 6.8 | N/A                   | 10/35                       | 25.4 ± 4.4     | 16/29           |               |                          |
| Bergeat15      | 71/85            | 66.4 ± 10.1 | N/A                   | 26/130                      | 24.3 ± 3.6     | 47/109          |               |                          |
| Choi24         | 9/9              | 61.22 ± 11.63 | N/A                   | 3/20                        | N/A            | 16/6            | N/A           | 1178.3 ± 506.28          |
| Fisher25       | 24/26            | 62.61 ± 10.01 | N/A                   | 64/96                       | 1/300          | N/A             |               |                          |
| Roland26       | 50/50            | 64.4 ± 10.18 | 117/39                | N/A                        | N/A            | N/A             |               |                          |
| Kunstman27     | 156/75           | 62.6 ± 10.64 | 52/23                 | N/A                        | N/A            | N/A             |               |                          |
| Park28         | 64/61            | 63.15 ± 11.06 | 92/33                 | 25/100                     | 19/106         | N/A             |               |                          |
| Gaignard29     | 125/125          | 63.68 ± 13.97 | 94/31                 | 30/90                      | 66/59          | 504.6 ± N/A     |               |                          |
| Overall§       | 116/112          | 61.84 ± 9.25 | 88/24                 | 23/89                      | 22.7 ± 3.4     | 1993.7 ± 484.55 | N/A          |                          |
| 668/633        | 62/37            | 66.91 ± 2.7   | 77/22                 | 18/81                      | 24.02 ± 0.74   | N/A             |               |                          |
|                | 99/40            | 67.02 ± 3.29  | 25/15                 | 6/34                       | 24.17 ± 1.34   | N/A             |               |                          |
|                | 346/322          | 64.80 (95% c.i. 62.74,66.93) | 370/93                | 23.74 (95% c.i. 23.20,24.30) | 322/282      | 539.39 (95% c.i. 179.89,1617.29) | N/A          |                          |
|                | 314/319          | 64.19 (95% c.i. 62.65,65.76) | 238/727               | 23.81 (95% c.i. 23.25,24.38) | 278/318        | 622.7 (95% c.i. 205.19,1890.16) | N/A          |                          |
|                | 0.51             | 0.44      | 0.19                  | 0.90                       | 0.51           | 0.60            | 0.28          |                          |

*Nasogastric decompression (NGD) via tube gastrostomy in Park study. †The no NGD group in Kunstman study had nine of 125 patients who had a nasogastric tube postoperatively. §Roland et al. reported the number of pancreaticoduodenectomy, including Whipple’s and PPPD, collectively. Continuous variables are reported as weighted means. ‡Roland et al. reported the number of pancreaticoduodenectomy, including Whipple’s and PPPD, collectively. ‡Continuous variables are reported as weighted means.
anatomy and motility patterns of the stomach after PD. Post-PD DGE remains complex and is likely multifactorial. However, evidence from this review suggests routine NGD may not be as beneficial as has been commonly thought. The fact that complications remained similar between groups, in particular POPF, and yet DGE rates were higher in those receiving routine NGD, adds confidence to the finding that DGE may be associated with routine NGD.

All included studies in this systematic review and meta-analysis were consistent in recommending against routine NGD after PD13,15,24–29. Kunstman et al. reported a lower incidence of DGE in those without routine NGD 27. The incidence of CR-DGE

| Study characteristics | Country | Period of patient inclusion | Study design | Comparison groups | Selection to NGD versus no NGD based on | Inclusion and exclusion criteria |
|-----------------------|---------|-----------------------------|--------------|------------------|----------------------------------------|----------------------------------|
| Kleive13               | Norway  | 2 years (2015–2016)         | Prospective observational | NGD versus no NGD reinsertion | NGT was removed immediately postoperatively in all patients and reinserted if indicated | Inclusion: All patients who underwent PD |
|                       |         |                             |              |                  |                                        | Exclusion: Other types of pancreatic resections |
| Bergeat15              | France  | 2.6 years (January 2016–August 2018) | RCT | NGD versus no NGD | Randomized | Inclusion: All patients aged between 18 and 75 years requiring PD for benign or malignant biliopancreatic confluence lesions |
|                       |         |                             |              |                  |                                        | Exclusion: Previous gastric/oesophageal surgery |
|                       |         |                             |              |                  |                                        | Chronic respiratory disease |
|                       |         |                             |              |                  |                                        | Heart failure |
|                       |         |                             |              |                  |                                        | Pregnancy or nursing mothers |
|                       |         |                             |              |                  |                                        | Patients under guardianship |
| Gaignard29             | France  | 2 years (2014–2015)         | Prospective, comparative | NGD versus no NGD | Two cohorts: before May 2015, all patients had routine NGD; after May 2015, all patients had NGT immediately removed postoperatively | Inclusion: All patients who underwent PD |
|                       |         |                             |              |                  |                                        | Exclusion: N/A |
|                       |         |                             |              |                  |                                        | Inclusion: All patients who underwent PD |
|                       |         |                             |              |                  |                                        | Exclusion: Patients who underwent PPPD |
|                     |         |                             |              |                  |                                        | Exclusion: N/A |
| Choi24                | Korea   | 3 years (July 2004–May 2007) | Retrospective | NGD versus no NGD | N/A | Inclusion: All patients who underwent PD |
|                       |         |                             |              |                  |                                        | Exclusion: N/A |
| Park28                 | Korea   | 5 years (2009–2014)         | Prospective, comparative | NGD versus no NGD | Two cohorts: before June 2012, all patients had routine NGD; after July 2012, all patients had NGT immediately removed postoperatively | Inclusion: 100 consecutive patients who underwent PD or DP |
|                       |         |                             |              |                  |                                        | Exclusion: Other types of pancreatic resections |
|                      |         |                             |              |                  |                                        | Exclusion: N/A |
| Fisher25               | USA     | 2.75 year (January 2008–September 2010) | Prospective, comparative | NGD versus no NGD | Two cohorts: first 50 patients had routine NGD; second 50 patients had NGT immediately removed in operating room | Inclusion: N/A |
|                       |         |                             |              |                  |                                        | Exclusion: N/A |
| Roland26               | USA     | 13.5 years (1997–May 2011)  | Prospective, comparative | NGD versus no NGD | Two cohorts: before May 2006, all patients had routine NGD; after May 2011, all patients had NGT removed in operating room | Inclusion: All patients aged above 14 years and who underwent pancreatic resections |
|                       |         |                             |              |                  |                                        | Exclusion: N/A |
| Kunstman27             | USA     | 8.5 years (July 2003–February 2012) | Prospective, comparative | Routine NGD versus selective NGD | Two cohorts: first 125 patients had routine NGD; second 125 patients had NGD only in selective indications | Inclusion: Patients undergoing PD |
|                       |         |                             |              |                  |                                        | Exclusion: N/A |

NGD, nasogastric decompression; NGT, nasogastric tube; PD, pancreaticoduodenectomy; N/A, not available; PPPD, pylorus-preserving pancreaticoduodenectomy.
The Mantel–Haenszel random-effects model was used for the meta-analysis of all outcomes. Odds ratio (OR) are shown with 95 per cent confidence intervals.
The Mantel–Haenszel random-effects model was used for the meta-analysis of all outcomes. Odds ratio (OR) are shown with 95 per cent confidence intervals.
was also lower in those without routine NGD. Two studies also reported significantly higher rates of postoperative Clavien–Dindo grade II or higher complications with routine NGD. Several studies reported shorter length of stay and a better understanding of the underlying pathophysiology may guide management.

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**Supplementary material**

Supplementary material is available at *BJS Open* online.

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