ORIGINAL ARTICLE

A Fast Track Recovery Program Significantly Reduces Hospital Length of Stay Following Uncomplicated Pancreaticoduodenectomy

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ABSTRACT

Context Factors affecting length of hospital stay after uncomplicated pancreaticoduodenectomy have not been reported. We hypothesized that patients undergoing uncomplicated pancreaticoduodenectomy treated by fast track recovery program would have a shorter length of hospital stay compared to those managed by a standard program. **Methods** Patients without surgical or medical complications following pancreaticoduodenectomy managed by fast track or standard protocols, between 2005 and 2011, were identified and prognostic predictors for length of hospital stay determined. **Results** Forty-one patients treated by pancreaticoduodenectomy had no medical or surgical complications during this period. Of these patients, 20 underwent fast track recovery program compared to 21 who underwent standard care. Patients in the standard group were more likely to have a feeding jejunostomy tube (P<0.001), pylorus preserving procedure (P=0.001) and a nasogastric tube in place longer than 24 hours postoperatively (P<0.001). The median postoperative length of stay was shorter in the fast track recovery program group (8 days, range: 7-16 days) *versus* 14 days, range: 8-29 days; P<0.001). There were three readmissions in the fast track recovery program related to abdominal pain and none in the standard group. The overall length of stay, accounting for readmissions, still remained significantly shorter in the fast track recovery program group (median 9 days, range: 7-17 days *versus* median14 days, range: 8-29 days ; P<0.001). There were no significant differences in discharge destination between groups. On multivariate analysis, the only factor independently associated with postoperative discharge by day 8 was fast track recovery program (OR: 37.1, 95% CI: 4.08-338; P<0.001). **Conclusion** Fast track recovery program achieved significantly shorter length of stay following uncomplicated pancreaticoduodenectomy.

INTRODUCTION

Factors affecting length of hospital stay after uncomplicated pancreaticoduodenectomy have not been reported. The concept of fast track recovery program(s) is well described in the setting of colorectal surgery and is increasingly applied to other surgical disciplines [1, 2, 3]. Reported outcomes of fast track recovery program after colorectal surgery include earlier hospital discharge and reduced complications [4, 5, 6], however the benefit of fast track recovery program following uncomplicated pancreatico-duodenectomy is not established [7, 8, 9, 10].

Received September 23rd, 2012 – Accepted December 6th, 2012

Key words Length of Stay; Outcome Assessment (Health Care); Pancreatectomy; Patient Readmission; Postoperative Complications

Abbreviations ISGPS: International Study Group of Pancreatic Surgery

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The role of fast track recovery program in the setting of pancreaticoduodenectomy is uncertain due to the heterogeneity of patients studied and a lack of randomized trials [7, 8, 9, 10, 11]. It is difficult to postulate that fast track recovery program prevents certain surgical complications following pancreatico-duodenectomy such as pancreatic fistula, biliary leak, hemorrhage, intra-abdominal collections and delayed gastric empting. It is, however, possible that fast track recovery program promotes quicker recovery after development of certain complications and reduces the severity of others.

Whether fast track recovery program alters length of hospital stay and readmissions in patients without complications following pancreaticoduodenectomy has not been previously determined. In this retrospective study, patients undergoing uncomplicated pancreatico-duodenectomy managed by either fast track or standard recovery programs were compared. Postoperative lengths of stay and hospital readmission outcomes were evaluated. Patients with complications following pancreaticoduodenectomy were excluded to improve grouping homogeneity, and minimize potential inclusion of patients with adverse outcomes related to technical errors.

PATIENTS AND METHODS

Patient Population

All patients undergoing pancreaticoduodenectomy from August 2005 to December 2011 were identified from a prospectively maintained hospital database with Human Research Ethics Committee approval and those without a perioperative complication identified. A fast track recovery program was first introduced in August 2009. A complication was considered any unexpected event during surgery or the postoperative period. Pancreatic surgery complications were determined according to the International Study Group of Pancreatic Surgery (ISGPS) criteria where available [12, 13, 14]. Delayed gastric empting was based on the international definition of inability to tolerate a diet by day 7 postoperatively. Some surgeons in the standard group maintained a nasogastric tube, positioned in the biliopancreatic limb of the small intestine to provide decompression for 4-5 days. The placement of nasogastric tube for this purpose was not considered delayed gastric emptying under these circumstances if the patient was able to tolerate a diet by day 7 postoperatively. Patient demographics, perioperative details, and clinicopathological features were compared as independent prognostic factors for length of hospital stay.

Preoperative Details

Demographic data, laboratory tests and indications for surgery were recorded for all patients. Patients within the fast track recovery program group were prescribed 5 to 7 days of Impact Advanced Recovery® (Nestle, Sydney, NSW, Australia) 0.5-1 L/day supplementation prior to surgery. Sodium picosulfate (Picoprep®; Ferring Pharmaceuticals, Pymble, NSW, Australia) bowel preparation was administered the day prior to surgery. Expectations and time course of recovery were explained in detail routinely in the fast track recovery program group at the time of obtaining consent for surgery by the consulting surgeon. Patients in both groups had 6 hours fasting prior to surgery.

Operative Details

Six consultant surgeons performed one or more pancreaticoduodenectomy during this study period. General anesthesia was managed by specialist anesthesiologists. Operative details were recorded, including operative time and estimated blood loss. Prophylactic antibiotics and subcutaneous heparin was administered in all cases. In the fast track recovery program group a classic pancreaticoduodenectomy was performed, with a duct to mucosa pancreaticojejunal anastomosis, and an antecolic gastrojejunal anastomosis was fashioned as previously described [15]. Feeding jejunostomy tubes were not utilized routinely in the fast track recovery program group. They were utilized only in patients with preoperative malnutrition, despite acceptable oral intake that were thought to significantly benefit from additional enteral supplementation. All of these patients had preoperative dietician assessment.

In the standard group, classic or pylorus preserving pancreaticoduodenectomy was performed according to surgeon preference. Patients had a feeding jejunostomy tube inserted depending on surgeon preference and not purely on their preoperative nutritional assessment. All had a pancreaticojejunostomy, using a two layer invaginating type anastomosis. Antecolic gastrojejunal or duodenojejunal anastomoses were performed. Selected cases had a gastrostomy tube inserted. Abdominal drains were placed adjacent to pancreatic and biliary anastomoses in both treatment groups.

Postoperative Details

Patients were treated in an intensive care unit setting for 12 to 24 hours, unless further monitoring was required. Patients had epidural, intrathecal or patient controlled intravenous analgesia as determined by the anesthetic team and based on indicated patient preference prior to the day of surgery. Analgesia requirements were monitored in both groups by a dedicated anesthetic pain service team.

In the fast track recovery program group, nasogastric tube removal was performed the morning following surgery, unless there was more than 300 mL drainage in a 6-hour period. A liquid diet was commenced day 2 postoperatively. There was progression from fluid intake to a soft diet as tolerated over the next few days. The right and left drains were checked for amylase and bilirubin at day 5 and were removed if there was no evidence of any pancreatic or biliary leakage. In the fast track recovery program group, erythromycin was given intravenously at 200 mg every 6 hours starting on day 2 postoperatively and continued until a soft diet was tolerated. Metoclopramide was administered intravenously at 10 mg every 6 hours following surgery until a soft diet was tolerated. Antibiotics were ceased after 24 hours. Acetaminophen was given intravenously or orally 1 g every 8 hours until patient discharge. Pancreatic enzyme supplements Creon (Abbott Pharmaceuticals, NSW, Australia) 25,000 units per meal and snack were prescribed once a soft diet was commenced. This was continued post-operatively with the dosage altered according to symptoms. Tight serum glucose control postoperatively to maintain a glucose level of less than 8 mmol/L was achieved by use of an insulin sliding scale. Patients were encouraged to mobilize out of bed from 6 hours postoperatively. Indwelling urinary catheters were removed by day 4 postoperatively unless otherwise required. Patients were administered frusemide 10-20 mg intravenously (Lasix®; Sanofi, NSW, Australia) following surgery if a positive fluid balance was recorded at 24 hours post-surgery or there was a postoperative weight gain of more than 1 kg. Diuretics were withheld if patients exhibited signs of hemodynamic instability or had evidence of acute renal impairment. Intravenous fluid administration (Hartman's solution) was reduced after 24 hours to 84

mL per hour postoperatively if the patient demonstrated no evidence of excess losses. It was further reduced to 42 mL hour at day 2 postoperatively once oral fluid intake was commenced. A proton pump inhibitor was administered intravenously following surgery and converted to oral dosage once a diet was tolerated and continued for at least two weeks post discharge. Laxatives, docusate sodium, 200 mg twelve hourly were commenced from day 4 post surgery to achieve regular bowel motions. Patients were discharged if they were self-caring and were tolerating a diet.

In the standard surgical group, postoperative management varied according to the individual surgeon's preferences. Nasogastric tubes were removed at varied times. Oral fluids were commenced at 24 to 48 hours postoperatively and progressed slowly to a soft diet as tolerated. A proton pump inhibitor was administered intravenously routinely and converted to oral dosage once a diet was tolerated. Erythromycin and metoclopramide were not routinely administered. Patients were mobilized as tolerated at 12 to 24 hours postoperatively. Fluids were administered to maintain a urine output of at least 30 to 50 mL/h. Diuretics were not routinely given and weight measurements were not performed postoperatively unless specifically requested. Acetaminophen 1 g every six hours was administered as required following surgery. Octreotide was administered routinely subcutaneously every eight hours for five to seven days. Abdominal drains were generally removed between 3 to 7 days post-surgery, depending on surgeon preferences in cases where there was no evidence of pancreatic or biliary leakage.

The main outcomes of interest in this study were length of hospital stay and 30 day post hospital discharge readmission rates. The final discharge destination was recorded in all cases. If there was a readmission, the reason for this and subsequent length of hospital stay was noted.

ETHICS

The study was approved by the Human Research Ethics Committee of Austin Health to conduct a retrospective review of patient outcomes. The study conforms to the ethical guidelines of the "World Medical Association (WMA) Declaration of Helsinki – Ethical Principles for Medical Research Involving Human Subjects" adopted by the 18th WMA General Assembly, Helsinki, Finland, June 1964 and amended by the 59th WMA General Assembly, Seoul, South Korea, October 2008. Because this study was not a prospective trial, no written informed consent was required to analyze data.

STATISTICS

A statistical software package (SPSS Version 19.0; IBM Co, Armonk, NY, USA) was used for statistical analysis, with two-tailed P value less than 0.05

Table 1. Characteristics of patients undergoing pancreaticoduodenal resection managed by fast-track and standard protocols. Data are shown as frequencies or median (range).

Patient characteristics	Overall (n=41)	Fast track group (n=20)	Standard group (n=21)	P value
Gender:				0.751 [a]
- Male	25 (61.0%)	13 (65.0%)	12 (57.1%)	
- Female	16 (39.0%)	7 (35.0%)	9 (42.9%)	
Age (years)	65 (15-81)	68 (45-81)	62 (15-81)	0.130 [b]
Body mass index (BMI; kg/m^2)	25 (19-42)	25 (19-42)	24 (19-34)	0.531 [b]
ASA class:				0.326 [a]
- II	14 (34.1%)	5 (25.0%)	9 (42.9%)	
- III	27 (65.9%)	15 (75.0%)	12 (57.1%)	
Biliary stent	10 (24.4%)	8 (40.0%)	2 (9.5%)	0.032 [a]
Diabetes	10 (24.4%)	7 (35.0%)	3 (14.3%)	0.159 [a]
History of pancreatitis	4 (9.8%)	2 (10.0%)	2 (9.5%)	1.000 [a]
Preoperative laboratory tests				
Hemoglobin (g/L)	129 (94-156)	125 (94-151)	131 (101-156)	0.389 [b]
White cell count (x10^9/L)	6.9 (3.0-16.8)	6.6 (3.4-11.7)	7.0 (3.0-16.8)	0.489 [b]
Platelets (x10^9/L)	286 (161-744)	252 (161-459)	304 (171-744)	0.489 [b]
C-reactive protein (mg/L)	5 (1-93)	5 (1-93)	6 (1-23)	0.757 [b]
Bilirubin (µmol/L)	19 (5-352)	48 (10-265)	17 (5-352)	0.044 [b]
Albumin (g/L)	35 (13-46)	36 (29-44)	35 (13-43)	0.489 [b]
Urea (mmol/L)	4.2 (0.8-12.8)	5.5 (1.9-12.8)	3.7 (0.8-8.5)	0.026 [b]
Creatinine (µmol/L)	69 (28-156)	69 (28-156)	69 (48-93)	0.794 [b]
Carcinoembryonic antigen (CEA; µg/L)	2.0 (0.6-18.2)	2.2 (0.6-18.2)	2.0 (1-8.0)	0.350 [b]
Carbohydrate antigen 19-9 (CA 19-9; U/mL)	59 (1-3,504)	83 (3-3,504)	26 (1-288)	0.117 [b]

ASA: American Society of Anesthesiologists
Missing values: BMI, n=8; CRP, n=12; CEA, n=13; CA 19-9, n=11
[a] Fisher's exact test
[b] Mann-Whitney U-test

Table 2. Operative details and pathology of patients undergoing pancreaticoduodenal resection managed by fast-track and standard protocols. Data are presented as frequencies or median (range).

	Overall (n=41)	Fast track group (n=20)	Standard group (n=21)	P value
Malignancy	34 (82.9%)	18 (90.0%)	16 (76.2%)	0.410 [a]
Segmental portal vein / SMV resection	4 (9.8%)	1 (5.0%)	3 (14.3%)	0.606 [a]
Partial portal vein / SMV resection	4 (9.8%)	2 (10.0%)	2 (9.5%)	1.000 [a]
Epidural anesthesia	27 (65.9%)	15 (75.0%)	12 (57.1%)	0.326 [a]
Classic Whipple procedure	32 (78%)	20 (100%)	12 (57.1%)	0.001 [a]
Main location of tumor:				0.020 [b]
- Pancreatic head	24 (58.5%)	7 (35.0%)	17 (81.0%)	
- Pancreatic uncinate	12 (29.3%)	10 (50.0%)	2 (9.5%)	
- Pancreatic neck/body	2 (4.9%)	1 (5.0%)	1 (4.8%)	
- Other	3 (7.3%)	2 (10.0%)	1 (.8%)	
Pancreas soft	10/33 (30.3%)	7 (35.0%)	3/13 (23.1%)	0.701 [a]
Pancreatic duct (≤3 mm)	17/32 (53.1%)	14 (70.0%)	3/12 (25.0%)	0.027 [a]
Number of nodes retrieved	11 (1-27)	11 (5-27)	11 (1-19)	0.095 [c]
R1 resection	9 (22.0%)	3 (15.0%)	6 (28.6%)	0.454 [a]
Estimated blood loss (mL)	450 (300-2,000)	475 (350-850)	450 (300-2,000)	0.874 [c]
Blood transfusions intra-operative	7 (17.1%)	1 (5.0%)	6 (28.6%)	0.093 [a]
Operative time (hours)	7.5 (3-12)	8 (6-12)	7 (3-10)	0.119 [c]
Feeding jejunostomy	10 (24.4%)	0 (0%)	10 (47.6%)	<0.001 [a]

SMV: superior mesenteric vein
Missing data: pancreatic texture, n=8; pancreatic duct diameter, n=9; number of nodes harvested, n=4
[a] Fisher's exact test
[b] Chi-square test
[c] Mann-Whitney U-test

considered statistically significant. Results were expressed as median (range) or frequencies unless otherwise stated. Comparisons between categorical variables were determined by chi-square and Fisher's exact test as appropriate. Non-categorical variables were assessed by the Mann-Whitney U-test. Multivariate analysis was undertaken using a backward stepwise logistic regression model to identify factors independently associated postoperative discharge by day 8, including all factors where the P value was less than 0.1 on univariate analysis. Odds ratios (OR) and 95% confidence intervals (CI) were noted.

RESULTS

Patient Characteristics

In total 121 patients underwent pancreatico-duodenectomy surgery during this period. In the fast track recovery program the complication rate was 42.9% (15 of 35 patients) compared to 75.6% (65 of 86 patients) in the standard group (P=0.001). Forty-one patients (33.9%) were identified as having no medical or surgical complication and were included in this study. Of these patients, 20 were treated within fast track recovery program compared to 21 by standard care. Five (23.8%) of the patients in the stander care group had their surgery after August 2009, during the same period at the fast track recovery program group. There were no significant differences in demographic characteristics between these two groups of patients (Table 1). More patients in the fast track recovery program group had preoperative biliary stenting compared to the standard group (8, 40.0% *versus* 2, 9.5%; P=0.032). The median bilirubin level prior to surgery was on average higher in the fast track recovery program group (48 µmol/L, range: 10-265 µmol/L *versus*17 µmol/L, range: 5-352 µmol/L; P=0.044), as was the urea level (5.5 mmol/L, range: 1.9-12.8 mmol/L *versus* 3.7 mmol/L, range: 0.8-8.5 mmol/L; P=0.026). There were no other significant differences in laboratory variables.

Operative and Perioperative Variables

Operative and pathology details of patients are summarized in Table 2. In the fast track recovery program group all had a classic pancreatico-duodenectomy compared to 12 (57.1%) patients in the standard group (P=0.001). Tumors in the fast track recovery program group were more likely located in the uncinate region than the head (P=0.001). The pancreatic duct was more commonly non-dilated in the fast track recovery program group (14, 70.0% *versus* 3, 25.0%); P=0.027), despite similar pancreatic texture. No feeding jejunostomy tubes were utilized in the fast track recovery program group compared to 10 (47.6%) cases in the standard management group (P<0.001). Nasogastric tubes were utilized in all fast track recovery program cases. One patient in the standard group had a gastrostomy tube inserted without the addition of a nasogastric tube. The operative time, estimated blood loss and intra-operative blood transfusion requirements, node harvest numbers and margin positivity were similar between the groups.

Postoperative Outcomes

Postoperative outcomes of patients are shown in Table 3. Nasogastric tube removal within 24 hours of surgery

Table 3. Postoperative and outcome details of patients undergoing uncomplicated pancreaticoduodenal resection managed by fast-track and standard protocols. Data are presented as frequencies or median (range).

	Overall (n=41)	Fast track group (n=20)	Standard group (n=21)	P value
Days in intensive care unit	1 (1-13)	1 (1-3)	1 (1-13)	0.633 [a]
Nasogastric removal day 1 post surgery	19/40 (47.5%)	19 (95.0%)	0/20 (0%)	<0.001 [b]
Discharged home	36 (87.8%)	18 (90.0%)	18 (85.7%)	1.000 [b]
Blood transfusion	8 (19.5%)	2 (10.0%)	6 (28.6%)	0.238 [b]
Negative fluid balance day 1 post surgery	3 (7.3%)	2 (10.0%)	1 (4.8%)	0.606 [b]
Negative fluid balance day 2 post surgery	15 (36.6%)	13 (65.0%)	2 (9.5%)	<0.001 [b]
Negative fluid balance day 3 post surgery	20 (48.8%)	11 (55.0%)	9 (42.9%)	0.538 [b]
Readmissions	3 (7.3%)	3 (15.0%)	0 (0%)	0.107 [b]
Initial postoperative length of stay (days)	10 (7-29)	8 (7-16)	14 (8-29)	<0.001 [a]
Overall length of stay including readmissions (days)	10 (7-29)	9 (7-16)	14 (8-29)	<0.001 [a]

Missing values: nasogastric tube removal day 1 post surgery, n=1
[a] Mann-Whitney U-test
[b] Fisher's exact test

occurred in 19 of 20 patients (95.0%) in the fast track recovery program group (P<0.001). Excluding the one patient in the standard group that had no nasogastric tube inserted, none had removal of their nasogastric tube within 24 hours of surgery.

Fluid balance on postoperative days 1 to 3 was compared between the groups. At day 2 postoperatively, a negative fluid balance was more common in the fast track recovery program group (13, 65.0% patients *versus* 2, 9.5% patients; P<0.001). No significant differences were noted during the other days. The median initial postoperative length of stay was shorter in the fast track recovery program group (8 days, range: 7-16 days *versus* 14 days, 8-29 days; P<0.001). There were three readmissions in the fast track recovery program related to complaints of abdominal discomfort. In none of these cases was a complication noted and patients were discharged home within a few days of readmission. There were no readmissions in the standard group (P=0.107 *versus* fast track recovery program). The overall length of stay, by taking into consideration readmissions, remained significantly shorter in the fast track recovery program group (median 9 days, range: 7-16 days *versus* 14 days, range: 8-29 days; P<0.001). The primary discharge destination was home in both groups.

Differences in length of stay could not be attributed to one particular factor according to patient records, except for those with feeding tubes, requiring training for tube management. A delay in discharge appeared to be multifactorial in the majority of cases and related to factors such as general patient fatigue, abdominal discomfort, inability to perform activities of daily living and poor mobility. In certain cases the reason for delay in discharge was indeterminate and may have been related to patient reluctance for discharge.

Factors Associated with Initial Hospital Discharge by Day 8 Post Surgery

The association of various factors with hospital discharge by day 8 days were assessed and shown in Table 4. The only factors on univariate analysis significantly associated with discharge by day 8 post surgery were fast track recovery program (OR: 37.1, 95% CI: 4.08-338; P<0.001), absence of a feeding jejunostomy (OR: 1.59, 95% CI: 1.19-2.12); P=0.002), while a negative fluid balance on day 2 post surgery resulted at the significant level (OR: 3.81, 95% CI: 0.97-14.9; P=0.050). On multivariate analysis, made by considering these variables together with preoperative diabetes and presence of biliary stent (i.e., all factors where the P value was less than 0.1 on univariate analysis), the only factor independently associated with postoperative discharge by day 8 was fast track recovery program (OR: 37.1, 95% CI: 4.08-338; P<0.001).

DISCUSSION

The concept of fast track surgery is increasingly applied to the management of different surgical and medical conditions. The aim in the case of surgical conditions is to provide optimal perioperative care to improve recovery, and reduce complications and length of stay [2, 4, 7, 8, 16]. The optimal perioperative management following pancreatic resection is difficult to define, with continuing controversy regarding methods to prevent certain complications such as pancreatic fistula, intra-abdominal collections and delayed gastric emptying. Outcomes may also vary significantly based on type of pancreatic resection, with differences between pancreaticoduodenectomy, total pancreatectomy and distal pancreatectomy. The reported outcomes of fast track recovery program in pancreatic surgery are often based on retrospective reports of heterogeneous pancreatic operations, being assessed for differences in complications and length of stay [8, 17, 18]. In our series, only patients undergoing pancreaticoduodenectomy that had no subsequent complications were included in order to assess the "true" impact of fast track recovery program on length of stay. Complications were significantly reduced with the introduction of fast track recovery program (data not presented), but patients with complications were excluded from this study as it was felt that there were

too many potential confounding factors contributing to the differences detected. Previous retrospective studies suggest that a fast track recovery program may reduce certain complications such as delayed gastric emptying, but as far as we aware, none have examined the impact of fast track recovery program on hospital length of stay, in the absence of surgical complications [8, 17, 18].

In our series, the operative technique in fast track recovery program group was standardized as was the perioperative management. The technique of resection and reconstruction was variable in the standard group. A modified definition of delayed gastric emptying was used in this study because some cases in the standard group had nasogastric tubes in place for 4 to 5 days to decompress the biliopancreatic limb of the small intestine, even in those tolerating a diet. According to ISGPS criteria, the maintenance of a nasogastric tube beyond 3 days is considered delayed gastric emptying [14]. In patients in the standard group, the placement of nasogastric tube did not impact an ability to tolerate a diet by day 7 postoperatively.

Length of postoperative stay is influenced by several factors and varies significantly between surgical units in different parts of the world. In some centers, there is an emphasis on early discharge either home or to a rehabilitation facility with a greater tendency to adopt clinical pathways for management. In other units, the length of hospital stay is longer, with a tendency to discharge patients home when they are self-caring and require minimal hospital supports [19, 20]. In our series discharge in both groups occurred when patients were considered to be self-caring, with no differences in discharge destination between the groups. Patients included in the fast track recovery program were those treated later in the study period between 2009-2011, whereas those in the standard group were treated between 2005-2011. There are increasing health-care demands for earlier hospital discharge and this may have impacted earlier discharge in the fast track recovery program group. The earlier discharge in the fast track recovery program group was however based on the same discharge criteria as in the standard group. One cannot deny that there are likely biases towards earlier discharge in the fast track recovery program group when there are set expectations from physicians, nurses, allied health practitioners and patients themselves who are aware of fast track pathways. We

Table 4. Results of univariate analysis of factors associated with discharge following pancreaticoduodenectomy by postoperative day 8. Data are presented as frequencies.

	Postoperative length of stay		Odds ratio (95% CI)	P value [a]
	8 days or less (n=14)	More than 8 days (n=27)		
Demographics				
Male gender	9 (64.3%)	16 (59.3%)	1.24 (0.33-4.71)	1.000
Body mass index (BMI) ≥30 kg/m^2	1 (7.1%)	1/19 (5.3%)	1.39 (0.08-24.2)	1.000
Age ≥70 years	5 (35.7%)	6 (22.2%)	1.94 (0.47-8.05)	0.463
Preoperative diabetes	6 (42.9%)	4 (14.8%)	4.31 (0.96-19.3)	0.064
ASA II	3 (21.4%)	11 (40.7%)	0.40 (0.09-1.76)	0.305
Biliary stent	6 (42.9%)	4 (14.8%)	4.31 (0.96-19.3)	0.064
Bilirubin ≥60 µmol/L	6 (42.9%)	6 (22.2%)	2.63 (0.65-10.6)	0.278
Albumin <30 g/L	2 (14.3%)	5 (18.5%)	0.73 (0.12-4.37)	1.000
Epidural anesthesia	11 (78.6%)	16 (59.3%)	2.52 (0.57-11.2)	0.305
Pathology				
Malignancy	12 (85.7%)	22 (81.5%)	1.36 (0.23-8.12)	1.000
R1 resection margin	4 (28.6%)	5 (18.5%)	1.76 (0.39-7.99)	0.692
Operative details				
Time ≥8 hours	2 (14.3%)	5 (18.5%)	0.73 (0.12-4.37)	1.000
Blood loss ≥600 mL	6 (42.9%)	6 (22.2%)	2.63 (0.65-10.6)	0.278
Blood transfusion intraoperative	1 (7.1%)	6 (22.2%)	0.27 (0.03-2.50)	0.389
Classic Whipple procedure	13 (92.9%)	19 (70.4%)	5.47 (0.61-49.2)	0.131
Absence of feeding jejunostomy tube	0 (0%)	10 (37.0%)	1.59 (1.19-2.12)	0.009
Postoperative details				
Fast-track recovery	13 (92.9%)	7 (25.9%)	37.1 (4.08-338)	<0.001
Blood transfusion postoperative	2 (14.3%)	6 (22.2%)	0.58 (0.10-3.36)	0.535
Negative fluid balance day 1	1 (7.1%)	2 (7.4%)	0.96 (0.08-11.6)	0.975
Negative fluid balance day 2	8 (57.1%)	7 (25.9%)	3.81 (0.97-14.9)	0.050
Negative fluid balance day 3	9 (64.3%)	11 (40.7%)	2.62 (0.69-9.96)	0.151

ASA: American Society of Anesthesiologists
Missing data: body mass index (BMI), n=8
[a] Fisher's exact test

believe that the inclusion of only uncomplicated patients increases the homogeneity of patient characteristics to further support the validity of our findings.

We noted a higher readmission rate in the fast track recovery program group due mainly to non-specific abdominal discomfort. A higher readmission rate has been reported in other fast track programs [1], but this difference did not reach statistical significance in our series. Retrospective fast-track pancreatic resection studies do not demonstrate increased re-admission rates [8, 17, 18]. The overall length of stay was still significantly lower in the fast track recovery program group than in the standard group, even taking into account readmissions. The implementation of a fast track recovery program for pancreatic surgery in other series has similarly shown reductions in length of stay [8, 11, 17, 18, 21].

There were several factors associated with a reduction in postoperative length of stay in this series, including a negative fluid balance on postoperative day 2, absence of a feeding jejunostomy and fast track recovery program. No patient with a feeding jejunostomy was discharged home by day 8 following surgery. This is explained by the added time needed to achieve a supplemental feeding regimen prior to hospital discharge and for patients to familiarize themselves with tube management requirements. Whilst a feeding jejunostomy may allow for earlier hospital discharge in cases where complications arise, in cases where there are no complications it appears to delay discharge. On multivariate analysis, fast track recovery program was, however, the only factor independently associated with reduced length of postoperative stay, incorporating absence of feeding tubes, minimization of intravenous fluids following surgery and aggressive diuresis of patients from 24 hours postoperatively. The accepted risk factors for increased complications, such as preoperative biliary stenting and small pancreatic duct, were higher in the fast track recovery program and did not lead to increased length of stay. The influence of these factors on complications was not accessed given that all patients with complications following pancreatico-duodenectomy were excluded from analysis. We do acknowledge that our series has all the limitations of a retrospective study and ideally a randomized trial should be performed determine the true benefits of fast track recovery program in both complicated and uncomplicated patients.

There are multiple factors possibly accounting for the benefits of fast track recovery program in our series. All patients had education sessions regarding expected outcomes after surgery. Preoperative patient education appears to be an integral component of most enhanced recovery programs [22, 23]. Pain management is equally important. Patients in both groups were managed by a dedicated hospital pain services team, although those in the fast track recovery program had routine administration of acetaminophen as part of their pain management. We did not assess in our study a return to bowel function, which has been used as fast track indicator in other series [2, 4, 7, 8, 16]. Active measures of preoperative bowel preparation and regular laxative following surgery were adopted in the fast track recovery program to minimize problems with constipation. In addition, pancreatic enzyme supplementation was prescribed routinely to prevent pancreatic insufficiency related diarrhea.

Postoperatively in the fast track recovery program group, there was a greater emphasis on mobilization, with instructions for patients to sit out of bed by 6 hours following surgery. It is well recognized that prolonged bed rest is associated with major detrimental cardiovascular, respiratory, musculoskeletal, and neuropsychological changes [24]. Nasogastric tube were removed early based on large randomized trials and meta-analysis indicating greater complications and inhibition of mobilization with nasogastric tube placement [25, 26]. Patients were also given routine antiemetics to minimize nausea. Octreotide was not administered in any patients in the fast track recovery program due to the lack of proven benefits in reducing pancreatic fistula and potential side effects including nausea and constipation [27]. Whether octreotide administration alone resulted in slower recovery in the standard group is uncertain. Minimization of postoperative fluids and aggressive diuresis in the fast track recovery program group was also considered important in preventing excess weight gain and pulmonary edema and improving mobility [28]. An association between excess fluid administration and anastomotic leaks related to intestinal edema has been noted following colorectal surgery [29].

CONCLUSION

Fast track recovery program appears to have significant benefits in recovery of patients following pancreaticoduodenectomy. The principles of enhanced perioperative recovery include many components and require a multidisciplinary collaboration between surgeons, physicians, anesthesiologist, intensivist and allied health staff. To date, this is the first study comparing fast track recovery program in uncomplicated patients following pancreatico-duodenectomy, convincingly showing significant benefits in reducing length of stay with such an approach. Further studies on the utility of fast track recovery program in preventing complications or reducing severity of complications following pancreaticoduodenectomy are required. This would ideally be conducted in a randomized trial including patients treated by similar techniques within high volume pancreatic surgery units. The ethics of performing a randomized study of patients undergoing pancreaticoduodenectomy treated by standard techniques compared to fast track recovery program must be questioned, given that many components of fast track programs are now evidence based. Fast track recovery program should be adopted for the

management of all patients undergoing pancreatico-duodenectomy.

Conflict interests The author has no potential conflict of interest

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