

World Journal of *Gastrointestinal Surgery*

World J Gastrointest Surg 2022 May 27; 14(5): 374-527



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Editorial Board Member of *World Journal of Gastrointestinal Surgery*, Chong-Chi Chiu, MD, Attending Doctor, Professor, Surgeon, Department of General Surgery, E-Da Cancer Hospital, Kaohsiung 82445, Taiwan. chiuchongchi@yahoo.com.tw

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The primary aim of *World Journal of Gastrointestinal Surgery* (*WJGS, World J Gastrointest Surg*) is to provide scholars and readers from various fields of gastrointestinal surgery with a platform to publish high-quality basic and clinical research articles and communicate their research findings online.

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INDEXING/ABSTRACTING

The *WJGS* is now abstracted and indexed in Science Citation Index Expanded (SCIE, also known as SciSearch®), Current Contents/Clinical Medicine, Journal Citation Reports/Science Edition, PubMed, and PubMed Central. The 2021 edition of Journal Citation Reports® cites the 2020 impact factor (IF) for *WJGS* as 2.582; IF without journal self cites: 2.564; 5-year IF: 3.378; Journal Citation Indicator: 0.53; Ranking: 97 among 212 journals in surgery; Quartile category: Q2; Ranking: 73 among 92 journals in gastroenterology and hepatology; and Quartile category: Q4.

RESPONSIBLE EDITORS FOR THIS ISSUE

Production Editor: *Rui-Rui Wu*, Production Department Director: *Xiang Li*; Editorial Office Director: *Ya-Juan Ma*.

NAME OF JOURNAL

World Journal of Gastrointestinal Surgery

ISSN

ISSN 1948-9366 (online)

LAUNCH DATE

November 30, 2009

FREQUENCY

Monthly

EDITORS-IN-CHIEF

Peter Schemmer

EDITORIAL BOARD MEMBERS

<https://www.wjgnet.com/1948-9366/editorialboard.htm>

PUBLICATION DATE

May 27, 2022

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INSTRUCTIONS TO AUTHORS

<https://www.wjgnet.com/bpg/gerinfo/204>

GUIDELINES FOR ETHICS DOCUMENTS

<https://www.wjgnet.com/bpg/GerInfo/287>

GUIDELINES FOR NON-NATIVE SPEAKERS OF ENGLISH

<https://www.wjgnet.com/bpg/gerinfo/240>

PUBLICATION ETHICS

<https://www.wjgnet.com/bpg/GerInfo/288>

PUBLICATION MISCONDUCT

<https://www.wjgnet.com/bpg/gerinfo/208>

ARTICLE PROCESSING CHARGE

<https://www.wjgnet.com/bpg/gerinfo/242>

STEPS FOR SUBMITTING MANUSCRIPTS

<https://www.wjgnet.com/bpg/GerInfo/239>

ONLINE SUBMISSION

<https://www.f6publishing.com>



Retrospective Cohort Study

Effect of overtime pancreaticoduodenectomy on the short-term prognosis of patients

Jin-Zhu Zhang, Shu Li, Wei-Hua Zhu, Xi-Sheng Leng, Da-Fang Zhang

Specialty type: Surgery

Provenance and peer review:

Unsolicited article; Externally peer reviewed.

Peer-review model: Single blind

Peer-review report's scientific quality classification

Grade A (Excellent): 0
Grade B (Very good): B
Grade C (Good): C
Grade D (Fair): 0
Grade E (Poor): 0

P-Reviewer: de Souza HSP, Brazil; Shah OJ, India

Received: December 26, 2021

Peer-review started: December 26, 2021

First decision: March 10, 2022

Revised: March 23, 2022

Accepted: April 21, 2022

Article in press: April 21, 2022

Published online: May 27, 2022



Jin-Zhu Zhang, Shu Li, Wei-Hua Zhu, Xi-Sheng Leng, Da-Fang Zhang, Department of Hepatobiliary Surgery, Peking University People's Hospital, Beijing 100044, China

Corresponding author: Da-Fang Zhang, MD, PhD, Assistant Professor, Assistant Statistician, Department of Hepatobiliary Surgery, Peking University People's Hospital, No. 11 Xizhimen South Street, Xicheng District, Beijing 100044, China. byronzdf@sina.com

Abstract

BACKGROUND

Due to the large number of operations, surgeons sometimes need to work overtime or even stay up late to perform pancreaticoduodenectomy. Fatigue and sleep deprivation can result in an increased error rate at work. There have been numerous studies about the effect of overtime surgery on the prognosis of patients. However, the effect of overtime work for pancreaticoduodenectomy on the prognosis of patients is unclear. This study explores the impact of overtime work for pancreaticoduodenectomy on the prognosis of patients.

AIM

To explore the impact of overtime work for pancreaticoduodenectomy on the short-term prognosis of patients.

METHODS

This was a single-center, retrospective cohort study. The patients who underwent pancreaticoduodenectomy between January 2017 and December 2019 were included. Patients were stratified by operative start time into the control group (surgery that started between 8:00 and 16:49) and the overtime group (surgery that started between 17:00 and 22:00) and compared intraoperative and postoperative parameters. The following parameters were compared between the overtime group and the control group: Operative time, blood loss, number of lymph nodes removed, duration of treatment in the Intensive Care Unit (ICU), and incidence of complications.

RESULTS

From January 2017 to December 2019, a total of 239 patients underwent pancreaticoduodenectomy in the Department of Hepatobiliary Surgery of our institution. Four patients were excluded from this study due to lack of clinical data. A total of 235 patients were included, with 177 in the control group and 58 in the overtime group. There was no difference between the two groups in operative time, blood

loss, number of lymph nodes removed, ICU length of stay, hospital length of stay, mortality during hospitalization. Compared with the control group, the overtime group had a higher incidence of pancreatic fistula (32.8% *vs* 15.8%, $P < 0.05$). Multivariate analysis showed that overtime work, higher Body Mass Index were independent risk factors for pancreatic fistula ($P < 0.05$).

CONCLUSION

Overtime work for pancreaticoduodenectomy increases the incidence of pancreatic fistula. The effect of overtime surgery on the long-term prognosis of patients' needs to be further studied.

Key Words: Pancreaticoduodenectomy; Fatigue; Surgery; Pancreatic fistula; General surgery; Overtime surgery

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Core Tip: The effect of overtime work for pancreaticoduodenectomy on the prognosis of patients is unclear. We explore the impact of overtime work for pancreaticoduodenectomy on the prognosis of patients. A total of 235 patients were included, with 177 in the control group and 58 in the overtime group. Overtime work for pancreaticoduodenectomy increases the incidence of pancreatic fistula. The effect of overtime surgery on the long-term prognosis of patients' needs to be further studied.

Citation: Zhang JZ, Li S, Zhu WH, Leng XS, Zhang DF. Effect of overtime pancreaticoduodenectomy on the short-term prognosis of patients. *World J Gastrointest Surg* 2022; 14(5): 419-428

URL: <https://www.wjgnet.com/1948-9366/full/v14/i5/419.htm>

DOI: <https://dx.doi.org/10.4240/wjgs.v14.i5.419>

INTRODUCTION

Due to the large number of operations, surgeons sometimes need to work overtime to perform elective surgery. When this occurs, surgeons performing the operation are faced with fatigue or even sleep deprivation. Fatigue and sleep deprivation affect cognitive function, leading to an increased error rate at work[1-3]. There have been numerous studies about the effect of overtime surgery on the prognosis of patients. However, the impact of surgery on patients due to surgeon fatigue and sleep deprivation is still controversial. Halvachizadeh *et al*[4] observed higher complication and mortality rates for after-hour orthopedic trauma surgery. Boscà *et al*[5] suggest that the prognosis of patients undergoing liver transplantation by fatigued surgeons is not poor. Brunshot *et al*[6] reported that nighttime kidney transplantation is associated with less pure technical graft failure.

Pancreaticoduodenectomy is widely used to treat pancreatic cancer, bile duct carcinoma, duodenal carcinoma, and ampullary carcinoma[7]. The operation is complicated[8], and usually lasts more than 5 h. Postoperative complications such as pancreatic fistula, delayed gastric emptying, abdominal infection, and postoperative hemorrhage are prone to occur[9]. Extensive literature has clarified the risk factors related to complications after pancreaticoduodenectomy[10,11]. At present, there is no report on the effect of pancreaticoduodenectomy over time on the prognosis of patients. Therefore, the study explores the impact of overtime work for pancreaticoduodenectomy on the prognosis of patients.

MATERIALS AND METHODS

Study design and population

Approval of the Ethics Committee of the Peking University People's Hospital was obtained. Patients who underwent pancreaticoduodenectomy at the Department of Hepatobiliary Surgery, Peking University People's Hospital from January 2017 to December 2019 were reviewed. Patients with missing clinical data were excluded. All patients were scheduled to undergo elective surgery. The center stipulates that the working hours of surgeons are 8:00-17:00 from Monday to Friday. The definition of overtime surgery in this study is that the surgeon starts the operation after 17:00. So Patients were stratified by operative start time into the control group (surgery that started between 8:00 and 16:49) and the overtime group (surgery that started between 17:00 and 22:00). Since the off-hours in our institution begin at 17:00, five o'clock was set as the cutoff point. The operating room did not accept new elective surgery after 22:00.

Table 1 Preoperative clinical characteristic of all patients

Characteristic	Total (n = 235)
Age (median, range), yr	64 (range 14-89)
Sex, n (%)	
Male	153 (65.1)
Female	82 (34.9)
Preoperative comorbidities, n (%)	
Diabetes	46 (19.6)
Hypertension	98 (37.4)
Coronary heart disease	19 (8.1)
Hepatobiliary and pancreatic diseases	46 (19.6)
Location of the lesions, n (%)	
Pancrea	95 (40.4)
Bile duct	81 (34.6)
Duodenum	59 (25.1)

The following parameters were included as possible confounders: patient age, sex, body mass index (BMI), American Society of Anesthesiologists grade, preoperative comorbidities, preoperative total bilirubin, site of lesion, surgeon, technique of reconstruction, and technique of pancreaticojejunostomy. The following parameters were compared between the overtime group and the control group: operative time, blood loss, number of lymph nodes removed, duration of treatment in the Intensive Care Unit (ICU), incidence of complications and number of hospital death.

Surgery and surgeons

A total of 6 surgeons performed pancreaticoduodenectomy at the institution. All surgeons had more than 10 years of experience in performing pancreaticoduodenectomy. Each surgeon performed operations two days a week. Karolinska Sleepiness Scale (KSS)[12] was used to assess surgeon sleepiness. The surgeons involved in this study self-assessed their level of sleepiness for each surgery, and expressed with KSS.

Pancreaticoduodenectomy was used to treat pancreatic cancer, cholangiocarcinoma, duodenal cancer, ampullary cancer, and a small number of benign diseases. All pancreaticoduodenectomy were performed by laparotomy. Roux-en-y or child surgery was used to reconstruct the digestive tract, and pancreaticojejunostomy was performed by duct-mucosa or invagination.

Definition of postoperative pancreatic fistula and delayed gastric emptying

A clinically relevant postoperative pancreatic fistula is defined as a drain output of any measurable volume of fluid with an amylase level > 3 times the upper limit of institutional normal serum amylase activity[13]. Delayed gastric emptying was defined as the patient not removing the gastric tube or needing to have the tube reinserted for more than 3 d after the operation[14]. Delayed gastric emptying can be classified as grade A (3-7 d), B (8-14 d), and C (more than 14 d) according to the duration of retention of the gastric tube. In this study, only grades B and C of delayed gastric emptying were included in the postoperative complication analysis.

Statistical analysis

Continuous variables were tested with the Shapiro-Wilk test to determine whether they were normally distributed. Continuous variables that were proven to have a normal distribution are reported as the mean and standard deviation. Otherwise, continuous variables are reported by medians. Categorical variables are reported as frequencies or percentages. Continuous, normally distributed variables were compared with the t-test and non-normally distributed variables were compared with the Mann-Whitney test. The chi-square test was used to compare categorical variables. Reverse stepwise multivariable logistic regression was performed to assess the effects of the potential covariates on outcome. Variables with p-values less than 0.2 in univariate logistic regression models will be included in the multivariable logistic regression analysis. P values less than 0.05 were considered significant. Data were analyzed in Statistical Package for the Social Sciences version 21.0 (SPSS 21.0). The study was reviewed by our expert Biostatistic Da-Fang Zhang.

Table 2 Patient characteristics and operative parameters

	Control group (n = 177)	Overtime group (n = 58)	P value
Age (yr)	63 (14-89)	64 (29-84)	0.987
Sex			0.694
Male	114 (64.4%)	39 (67.2%)	
Female	63 (35.6%)	19 (32.8%)	
BMI (kg/m ²)	22.7 (14.8-36.8)	22.9 ± 2.79	0.922
ASA classification			0.227
I	14 (7.9%)	3 (5.2%)	
II	130 (73.4%)	49 (84.5%)	
III	33 (18.6%)	6 (10.3%)	
History of hepatobiliary and pancreatic disease	32 (18.1%)	14 (24.1%)	0.313
Diabetes	33 (18.6%)	13 (22.4%)	0.53
Hypertension	67 (37.9%)	21 (36.2%)	0.822
Coronary artery disease	14 (7.9%)	5 (8.6%)	0.863
Cerebrovascular disease	16 (9.0%)	2 (3.4%)	0.165
Preoperative total bilirubin	85.8 (5.4-793.5)	93.8 (5.3-610.2)	0.566
Primary site			0.644
Pancreas	74 (41.8%)	21 (36.2%)	
Bile duct	61 (34.5%)	20 (34.5%)	
Duodenum	42 (23.7%)	17 (29.3%)	
Surgeon			0.085
A	21 (11.9%)	5 (8.6%)	
B	30 (16.9%)	17 (29.3%)	
C	32 (18.1%)	13 (22.4%)	
D	17 (9.6%)	6 (10.3%)	
E	34 (19.2%)	3 (5.2%)	
F	43 (24.3%)	14 (24.1%)	
Technique of reconstruction			0.233
Roux-en-Y	94 (53.1%)	36 (62.1%)	
Child surgery	83 (46.9%)	22 (37.9%)	
Pancreaticojejunostomy technique			0.686
Duct-to-mucosa	53 (29.9%)	19 (32.8%)	
Invagination	124 (70.1%)	39 (67.2%)	
Operative time (min)	413 (260-796)	421.1 ± 83.4	0.757
Blood loss (mL)	600 (100-4700)	700 (150-2800)	0.185
Number of lymph nodes removed	9 (0-62)	10 (1-45)	0.994

BMI: Body mass index.

RESULTS

Preoperative clinical characteristic

From January 2017 to December 2019, a total of 239 patients underwent pancreaticoduodenectomy in the Department of Hepatobiliary Surgery of our institution. Four patients were excluded from this

Table 3 Intraoperative and postoperative clinical characteristic of all patients

Characteristic	Total (n = 235)
Operating time (median, range), min	416 (260-796)
Blood loss volume (median, range), mL	600 (100-4700)
Number of lymph nodes removed (median, range)	10 (0-62)
ICU length of stay (median, range), h	16 (0-518)
Hospital length of stay (median, range), d	19 (7-160)
Postoperative complications, n (%)	
Pancreatic fistula	47 (20.0)
Delayed gastric emptying (B/C)	39 (16.6)
Gastrointestinal bleeding	25 (10.6)
Abdominal infection	14 (3.0)
Pneumonia	6 (2.6)
Arrhythmia	6 (2.6)
Thromboembolism	2 (0.9)
Respiratory failure	1 (0.4)
Gastrointestinal bleeding	1 (0.4)
Death during hospitalization, n (%)	
Gastrointestinal bleeding	2 (0.9)
Pancreatic fistula	4 (1.7)
Abdominal infection	1 (0.4)
Pneumonia	3 (1.3)

ICU: Intensive Care Unit.

Table 4 Postoperative factors and complications

	Control group (n = 177)	Overtime group (n = 58)	P value
Operative time (min)	413 (260-796)	421.1 ± 83.4	0.757
Blood loss (mL)	600 (100-4700)	700 (150-2800)	0.185
Number of lymph nodes removed	9 (0-62)	10 (1-45)	0.994
Duration of treatment in ICU after surgery	17 (0-325)	14 (0-518)	0.511
Duration of postoperative hospitalization	20 (7-160)	18 (7-61)	0.181
Postoperative pancreatic fistula	28 (15.8%)	19 (32.8%)	0.005
Delayed gastric emptying (B/C)	30 (16.9%)	9 (15.5%)	0.799
Gastrointestinal bleeding	17 (9.6%)	8 (13.8%)	0.369
Abdominal infection	12 (6.8%)	2 (3.4%)	0.352
Pneumonia	3 (1.7%)	3 (5.2%)	0.162
Arrhythmia	6 (3.4%)	0	0.341
Thromboembolism	2 (1.1%)	0	1.000
Respiratory failure	1 (0.6%)	0	1.000
Hemothorax	1 (0.6%)	0	1.000
Hospital death	7 (4.0%)	3 (5.2%)	0.690

ICU: Intensive Care Unit.

study due to lack of clinical data. A total of 235 patients were included in this study. A total of 177 (75.3%) patients underwent surgery before 16:59. In addition, 58 (24.7%) patients underwent surgery after 17:00. The median age of the patients was 64 (range 14-89) years. There were 153 (65.1%) males and 82 (34.9%) females. The preoperative clinical characteristic of all patients were shown in [Table 1](#). There was no significant difference in any baseline characteristic between the two groups of patients ([Table 2](#)).

Outcome

The intraoperative and postoperative clinical characteristic of all patients were shown in [Table 3](#). Ten patients (4.3%) died during postoperative hospitalization. Of the ten patients who died, 2 died of gastrointestinal bleeding, 4 died of pancreatic fistula, 3 died of pneumonia, and 1 died of abdominal infection. Compared with the control group, the overtime group had a higher incidence of pancreatic fistula (32.8% *vs* 15.8%, $P = 0.005$). There was no difference between the two groups in operative time, blood loss, number of lymph nodes removed, ICU length of stay, hospital length of stay, mortality during hospitalization or complications except pancreatic fistula ([Table 4](#)).

Univariate and multivariate logistic regression analysis of the risk factors for pancreatic fistula

To identify the prognostic factors of pancreatic fistula, we performed univariate and multivariate logistic regression analyses. In the multivariate logistic regression, parameters that significantly increased the risk of pancreatic fistula were high BMI and overtime surgery ([Tables 5 and 6](#)).

KSS of surgeons during overtime and non-overtime operations

The average values of KSS in the control group and overtime group were 1.95 ± 0.6 and 6.4 ± 1.0 , respectively. The statistical analysis demonstrates differences between groups regarding KSS ($P < 0.001$), with increased mean KSS in overtime group ([Table 7](#)).

DISCUSSION

Due to the large demand for surgery, surgeons often need to work overtime or even stay up late to complete a surgery. In a state of fatigue and sleep deprivation, surgeons may make more mistakes during the operation, which may result in a worse prognosis for the patient after surgery. McCormick *et al* [15] reported that residents' fatigue levels were predicted to increase the risk of medical error by 22% compared with well-rested historical control subjects. Taffinder *et al* [16] found that surgeons who were sleep deprived made 20% more mistakes in laparoscopic procedures and had an increase in operating time of 14%. Because of pancreaticoduodenectomy is complicated operation with long operation time, its requirements for the surgeon's physical and mental stamina are higher. Although a large number of studies on pancreaticoduodenectomy have been reported. To the best of our knowledge, our study is the first to explore the relationship between the overtime surgery and the short-term prognosis of pancreaticoduodenectomy. All surgeons at our center perceive a decrease in alertness during overtime surgery. Therefore, the KSS of the overtime group were higher than control group. This means that surgeons tend to be fatigued when they work overtime.

There was no significant difference in the preoperative and intraoperative results of patients between the overtime group and the control group. However, the postoperative results showed that the overtime group had a higher incidence of pancreatic fistula. In the multivariate regression analysis, operation time was still the influencing factor on pancreatic fistula. The incidence of pancreatic fistula in the night shift group was approximately twice that in the day shift group (32.8% *vs* 15.8%). In addition, elevated BMI was risk factors for pancreatic fistula. Relevant studies have confirmed that high BMI is a risk factor for pancreatic fistula [17,18]. High BMI causes abdominal fat to increase, which in turn leads to increased difficulty in surgery, thereby increasing the incidence of pancreatic fistula.

Pancreatico-enteric anastomosis in pancreaticoduodenectomy places stricter requirements on the operation of the surgeon. Due to more than 8 h of work during the day, the surgeon is physically and mentally exhausted, which may lead to a decline in surgical proficiency. Therefore, overtime surgery may cause a significant increase in the incidence of pancreatic fistula. This study confirmed that overtime pancreaticoduodenectomy increased the incidence of postoperative pancreatic fistula in patients. According to previous literature [19-21], about 16.3%-23.9% of patients who underwent pancreaticoduodenectomy developed pancreatic fistula after surgery. The result was consistent with the report in our center. Postoperative pancreatic fistula can prolong the patients' hospital stay, increase the patient's medical expenses, and even lead to the patient's death. So avoiding pancreatic fistula as much as possible is crucial for surgeons.

Table 5 P values, odds ratios, and selected 95%CI for pancreatic fistula from univariate logistic regression models

Parameter	P value	Odds ratio	95%CI
Age (yr)	0.474	1.011	0.981-1.042
Male	0.068	1.986	0.951-4.149
BMI (kg/m ²)	0.036	1.113	1.007-1.229
ASA classification			
I	0.723	0.733	0.132-4.066
II	0.373	1.532	0.599-3.920
III		Reference	
History of hepatobiliary and pancreatic disease	0.368	0.669	0.278-1.607
Diabetes	0.368	0.669	0.278-1.607
Hypertension	0.071	1.813	0.950-3.460
Coronary artery disease	0.905	1.073	0.339-3.396
Cerebrovascular disease	0.714	0.786	0.218-2.837
Preoperative total bilirubin	0.324	1.001	0.999-1.003
Primary site			
Pancreas	0.581	0.777	0.317-1.905
Bile duct	0.087	2.063	0.899-4.735
Duodenum		Reference	
Surgeon			
A	0.44	1.482	0.545-4.030
B	0.55	0.757	0.303-1.888
C	0.308	0.605	0.231-1.589
D	0.053	0.127	0.016-1.028
E	0.076	0.339	0.103-1.119
F		Reference	
Overtime case	0.006	2.592	1.312-5.122
Reconstruction technique			
Roux-en-Y		Reference	
Child surgery	0.743	1.113	0.586-2.114
Pancreaticojejunostomy technique			
Duct-to-mucosa	0.572	1.217	0.617-2.4
Invagination		Reference	

BMI: Body mass index.

The institution stipulates that surgeons cannot start new elective operations after ten o'clock in the evening. However, clinicians need to complete a large number of surgical tasks on their own surgery days. To extend working hours, surgeons will schedule short-term operations such as cholecystectomy to be completed during the day and long-term operations such as pancreaticoduodenectomy to be performed near ten o'clock in the evening. Therefore, a large number of pancreaticoduodenectomies are performed after hours in our institution. Working overtime to perform pancreaticoduodenectomy reduces the safety of the operation and increases the incidence of postoperative pancreatic fistula. In addition, overtime work has an adverse effect on doctors' health. Studies have confirmed that overtime work will lead to an increase in the incidence of cardiovascular diseases[22,23].

The government and hospital administrators may need to take measures to change the situation where surgeons frequently work overtime or even stay up late for surgery. At the government level, investment in medical care should be increased to alleviate the shortage of medical resources. In

Table 6 *P* values, odds ratios, and selected 95%CI for pancreatic fistula from multivariate logistic regression models

Parameter	<i>P</i> value	Odds ratio	95%CI
BMI (kg/m ²)	0.034	1.12	1.008-1.243
Primary site			
Pancreas	0.773	0.873	0.346-2.201
Bile duct	0.062	2.273	0.960-5.380
Duodenum		Reference	
Overtime case	0.004	2.803	1.382-5.685

BMI: Body mass index.

Table 7 Karolinska Sleepiness Scale of surgeons during overtime and non-overtime operations

	Control group	Overtime group	<i>P</i> value
KSS	1.95 ± 0.6	6.4 ± 1.0	0

KSS: Karolinska Sleepiness Scale.

In addition, the government can legislate to limit the working hours of medical staff. At the hospital level, the clinical workload of surgeons should be appropriately reduced to ensure medical safety. Surgeons should try to avoid working overtime to perform pancreaticoduodenectomy. For patients undergoing overtime pancreaticoduodenectomy, surgeons should pay close attention to the amylase content of the patient's drainage fluid to find potential postoperative pancreatic fistulas in a timely manner.

There are still some limitations in this study. The subgroup analysis considering different diagnosis (not only location of lesions), and also different types of surgeries, and the different surgical teams, might render the final analysis difficult to interpret (due to small numbers considering the subgroups). Therefore, the results of this study should be interpreted with caution. Also, this study was a single-center retrospective cohort study, and only six surgeons performed pancreaticoduodenectomy. The conclusions of this study may not be convincing enough to extend to all institutions. Finally, this study did not analyze the long-term prognosis of patients, such as progression-free survival, and overall survival. More research is needed in the future.

CONCLUSION

Overtime pancreaticoduodenectomy may increase the incidence of postoperative pancreatic fistula. The government and hospital administrators may need to take measures to change the situation where surgeons frequently work overtime or even stay up late for surgery.

ARTICLE HIGHLIGHTS

Research background

Fatigue and sleep deprivation can result in an increased error rate at work. The effect of overtime work for pancreaticoduodenectomy on the prognosis of patients is unclear.

Research motivation

Overtime surgery may result in an increased incidence of intraoperative errors. This study is intended to be further clarified.

Research objectives

To explore the impact of overtime work for pancreaticoduodenectomy on the short-term prognosis of patients.

Research methods

Patients were stratified by operative start time into the control group (surgery that started between 8:00 and 16:49) and the overtime group (surgery that started between 17:00 and 22:00) and compared intraoperative and postoperative parameters.

Research results

The overtime group had a higher incidence of pancreatic fistula than control group (32.8% vs 15.8%, $P < 0.05$).

Research conclusions

The overtime group had a higher incidence of pancreatic fistula.

Research perspectives

This study did not analyze the long-term prognosis of patients, such as progression-free survival, and overall survival. More research is needed in the future.

FOOTNOTES

Author contributions: Zhang JZ designed the study, acquired and analyzed the data, and wrote the paper; Li S acquired and analyzed the data, and revised the paper; Zhu WH acquired and analyzed the data, and revised the paper; Leng XS revised the paper; Zhang DF designed the study, revised the paper, and supervised the study.

Supported by Peking University People's Hospital Scientific Research Development Funds, No. RDY2017-28.

Institutional review board statement: The study was reviewed and approved by the Peking University People's Hospital Institutional Review Board (Approval No. 2021PHB050-001).

Informed consent statement: All study participants, or their legal guardian, provided informed written consent prior to study enrollment.

Conflict-of-interest statement: No conflict-of-interest to declare.

Data sharing statement: No additional data are available.

STROBE statement: The authors have read the STROBE Statement-checklist of items, and the manuscript was prepared and revised according to the STROBE Statement-checklist of items.

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Country/Territory of origin: China

ORCID number: Jin-Zhu Zhang 0000-0001-6979-0539; Shu Li 0000-0002-0080-3562; Wei-Hua Zhu 0000-0002-4293-881X; Xi-Sheng Leng 0000-0001-5184-1035; Da-Fang Zhang 0000-0002-4613-806X.

S-Editor: Zhang H

L-Editor: A

P-Editor: Zhang H

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