



## Quality of life after pancreatic surgery

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### Abstract

#### BACKGROUND

Pancreatic surgery is challenging owing to the anatomical characteristics of the pancreas. Increasing attention has been paid to changes in quality of life (QOL) after pancreatic surgery.

#### AIM

To summarize and analyze current research results on QOL after pancreatic surgery.

#### METHODS

A systematic search of the literature available on PubMed and EMBASE was performed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. Relevant studies were identified by screening the references of retrieved articles. Studies on patients' QOL after pancreatic surgery published after January 1, 2012, were included. These included prospective and retrospective studies on patients' QOL after several types of pancreatic surgeries. The results of these primary studies were summarized inductively.

#### RESULTS

A total of 45 articles were included in the study, of which 13 were related to pancreaticoduodenectomy (PD), seven to duodenum-preserving pancreatic head resection (DPPHR), nine to distal pancreatectomy (DP), two to central pancreatectomy (CP), and 14 to total pancreatectomy (TP). Some studies showed that 3-6 months were needed for QOL recovery after PD, whereas others showed that 6-12 months was more accurate. Although TP and PD had similar influences on QOL, patients needed longer to recover to preoperative or baseline levels after TP. The QOL was better after DPPHR than PD. However, the superiority of the QOL between patients who underwent CP and PD remains controversial. The decrease in exocrine and endocrine functions postoperatively was the main factor affecting the QOL. Minimally invasive surgery could improve patients' QOL in the early

stages after PD and DP; however, the long-term effect remains unclear.

## CONCLUSION

The procedure among PD, DP, CP, and TP with a superior postoperative QOL is controversial. The long-term benefits of minimally invasive versus open surgeries remain unclear. Further prospective trials are warranted.

**Key Words:** Quality of life; Pancreaticoduodenectomy; Duodenum-preserving pancreatic head resection; Distal pancreatectomy; Central pancreatectomy; Total pancreatectomy

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**Core Tip:** This review summarizes and analyzes current research results on quality of life (QOL) after pancreatic surgery. The article covers the discussion and analysis of the QOL of various pancreatic surgeries. Which kind of surgical procedure has better QOL is controversial. The long-term benefits on QOL of minimally invasive surgery over open surgery are controversial.

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## INTRODUCTION

The pancreas, located in the retroperitoneum, is a glandular organ with endocrine and exocrine functions. It can be divided into four main parts: Head, neck, body, and tail. Pancreatic surgery can be divided into pancreaticoduodenectomy (PD), duodenum-preserving pancreatic head resection (DPPHR), distal pancreatectomy (DP), central pancreatectomy (CP), and total pancreatectomy (TP). Pancreatic surgery is challenging due to the organ's complex anatomical structure, peripheral vascularity, and intractable postoperative complications. Following the standardization of surgical steps and improvements in relevant medical techniques and surgical instruments, the safety of pancreatic surgery has significantly improved. Perioperative morbidity, mortality, and other related indicators have become more acceptable. However, owing to the organ's essential role in digestion, absorption, and blood glucose regulation, changes in the quality of life (QOL) of patients after pancreatic surgery have attracted the attention of surgeons.

More patients with non-malignant pancreatic diseases are willing to undergo surgical treatment because of the acceptable safety. In this case, from the perspective of the patient postoperatively, the significance of rehabilitation reflects the traditional perioperative outcome and QOL[1]. The QOL is a new concept that extends beyond health. Although there is no consensus on its conception[2], we can consider it a multi-dimensional architecture that incorporates objective and individual subjective views of aspects of one's physical, psychological, and social well-being[3-5]. It includes evaluating physical health, and many subscales, such as emotion, job, culture, family, sociability, economy, cognition, happiness, sex, and some symptoms[6]. Since people have realized the importance of QOL, many QOL scales have emerged, including the European Organization for Research and Treatment of Cancer QLQ-C30, European Quality of Life 5-dimension, 36-item Short, *etc.* However, it is challenging to follow up on patients' QOL once they are discharged from the hospital. Consequently, most relevant studies had small sample sizes or lacked long-term follow-up results. Moreover, a summary of studies on QOL after pancreatic surgery is lacking.

This study assessed the QOL in patients who underwent PD, DPPHR, DP, CP and TP. We conducted this study to describe the existing findings on the QOL after pancreatic surgery to make it easier for surgeons and patients to decide on a surgical approach. In addition, we attempted to identify controversial results to encourage further targeted research.

## MATERIALS AND METHODS

### Search strategy

This systematic review was conducted using PubMed and EMBASE databases, according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guideline[7]. Two authors (Li and Zhen) independently screened the articles after removing duplicates. Our search algorithm combined the terms: (1) "Pancreatic surgery" OR "pancreaticoduodenectomy" OR "duodenum-preserving pancreatic head resection" OR "distal pancreatectomy" OR "central pancreatectomy" OR "total pancreatectomy"; and (2) "Quality of life". Only articles written in English were included. The references of retrieved articles were screened for any relevant articles.

### Inclusion and exclusion criteria

Inclusion criteria: Articles involving the QOL of patients who underwent PD, DPPHR, DP, CP, and TP were included. The exclusion criteria were as follows: (1) Articles not within the scope of interest of this review; (2) Overlapping patient data; (3) Articles not published in English; and (4) Articles published before January 1, 2012.

## RESULTS

### Literature search

The search results are shown in [Figure 1](#). A total of 1515 potential studies were identified: 1313 from PubMed, 190 from EMABASE, and 12 additional references through a manual search. After excluding duplicates, 1453 articles were left. However, after screening titles and abstracts, 872 articles were excluded because they were outside the scope of this review. We also excluded article that were inaccessible ( $n = 127$ ). A total of 454 full-text articles were collected, of which 312 were excluded for language ( $n = 11$ ), not addressing the QOL after PD, DPPHR, DP, CP, or TP ( $n = 301$ ), or being published before January 1, 2012 ( $n = 97$ ). After the selection process, 45 clinical studies were included. The 45 articles included 13 on PD, seven on DPPHR, nine on DP, two on CP, and 14 on TP.

### Study characteristics for PD

Thirteen studies, including three randomized controlled trials (RCTs), four prospective observational studies, and six retrospective studies on PD were assessed. Six studies focused on perioperative QOL in patients with PD. Two RCTs and one retrospective study reported postoperative QOL changes after two years ([Table 1](#)). Some studies demonstrated that patients' QOL significantly diminished within one month post-operatively and nearly recovered to preoperative or baseline levels at three months after PD regardless of the pathology type[8-11], others reported that six months even one year was a more accurate period[12-14]. For long-term survivors, gastrointestinal symptoms such as bloating and indigestion are factors that affect their long-term QOL, and some of these symptoms are caused by pancreatic exocrine insufficiency after PD instead of post-operative complications[15,16]. Studies have reported that nearly half of the survivors required pancrelipase after PD[9,17,18]. Pancrelipase can improve nutritional status; however, its capacity to improve QOL is controversial[9,13,19].

Most studies have demonstrated that no differences between pylorus-preserving PD (PPPD) and conventional PD overall mortality, morbidity, survival, and QOL[20-24]. Studies have also shown that preoperative body weight loss, impaired preoperative pancreatic exocrine function, longer operative time, intraoperative radiotherapy, pancreatic carcinoma, and postoperative diarrhea may result in delayed QOL recovery[25].

Laparoscopic PD (LPD) could provide better QOL for patients with better functional status within six months postoperatively[26]. However, this advantage disappears after six months[27].

### Study characteristics for DPPHR

[Table 2](#) summarizes the results of the included articles on DPPHR. The sample sizes of the seven studies were 74, 80, 25, 40, 85, 17, and 16. Only one study examined the change in QOL within one year. One group of researchers reported that DPPHR and PD were comparatively effective in improving long-term QOL postoperatively[28-30]. Another group held that DPPHR could bring about better outcomes in the form of less frequent nausea, pain, and diarrhea, better physical status, working ability, and global QOL[31].

Studies have found that the Frey and the Berne approach had the advantages of shorter operation time and hospital stay duration compared to the Beger's. However, none showed any obvious difference in improving the patients' postoperative QOL[32-35].

### Study characteristics for DP

Nine studies included patients who underwent DP ([Table 3](#)). Two studies reported the perioperative QOL of patients who underwent DP, and seven mainly compared the differences between open and minimally invasive methods. Studies have shown that minimally invasive DP (MIDP) results in shorter hospital stays and functional recovery time compared to open DP (ODP)[36,37]. The MIDP group had better short-term QOL than the ODP group for up to 30 d postoperatively [38,39]. However, which is better for long-term QOL of > 1 year is controversial. During this period, some studies demonstrated no difference between MIDP and ODP[38,40], while others reported that MIDP could bring about better QOL for patients regarding physical, cognitive, social, and role functions, and symptoms, such as nausea, vomiting, and insomnia[41,42].

Laparoscopic spleen-preserving DP (LSPDP) and laparoscopic DP with splenectomy (LDPS) had similar perioperative outcomes[43]. Patients who underwent LSPDP had significantly better vitality than those who underwent LDPS, and were less likely to contract the common cold and flu[44,45].

The modified Appleby improved the ratio of R0 resection, relieved pain and improved patients' overall QOL[46].

### Study characteristics for CP

Details of the two studies on CP with sample sizes of 36 and 42 are included in [Table 3](#). Laparoscopic CP can help patients maintain better working and living conditions than open CP[47]. While comparing DP and PD, some researchers thought that CP showed a significant benefit in specific symptoms, such as loss of appetite, insomnia, nausea, and vomiting[48]. Others held different opinions that CP was associated with better pancreatic function but the same or even worse long-

**Table 1** Articles retrieved from literature reporting quality of life after pancreaticoduodenectomy

Ref.	Year	Country	Study design	Relevant patients	Total patients	Moments of assessment	Operation type	Questionnaires
Chan <i>et al</i> [12]	2012	Mexico	Prospective single-center study	37	37	PRE, 1, 3, 6 and 12 months	PD	SF-36
Gerstenhaber <i>et al</i> [11]	2013	Israel	Retrospective, single-center study	70	168	At discharge, 3, 6 and 12 months	PD	EORTC QLQ-C30
Rees <i>et al</i> [14]	2013	United Kingdom	Prospective single-center study	41	53	PRE, 6 wk, 3, 6, 12, 18 and 24 months	PD	EORTC QLQ-C30; EORTC QLQ-PAN26
Park <i>et al</i> [77]	2016	Korea	Retrospective, single-center study	10	15	10.5 (3, 18) yr	PPPD	EORTC QLQ-C30; EORTC QLQ-PAN26
Fong <i>et al</i> [9]	2017	United States	Retrospective, single-center study	245	305	9.1 (5.1, 21.2) yr postoperatively	PD	EQ-5D-5L; EORTC QLQ-C30
Laitinen <i>et al</i> [8]	2017	Finland	Prospective single-center study	47	47	PRE, 3, 6, 12, 18 and 24 months	PD	EORTC QLQ-C30; EORTC QLQ-PAN26
Heerkens <i>et al</i> [15]	2018	Netherlands	Prospective single-center study	118	137	1, 3, 6 and 12 months	PD	RAND-36; EORTC QLQ-C30; EORTC QLQ-PAN26
Diener <i>et al</i> [80]	2017	Germany	Multicenter, randomized controlled trial	226	250	24 months	PD and DPPHR	EORTC QLQ-C30; EORTC QLQ-PAN26
Allen <i>et al</i> [13]	2018	United States	Retrospective, global study	927	7605	2.0 (0.7, 4.3) yr	PD	SF-36; GSRS
Klaiber <i>et al</i> [24]	2020	Germany	Prospective, randomized controlled trial	96	188	PRE, 1 months, 34.3 (16, 57) months	PD and PPPD	EORTC QLQ-C30; EORTC QLQ-PAN26
Balduzzi <i>et al</i> [16]	2020	Italy	Retrospective, single-center study	47	75	60 (12, 240) months	PD	Pancreatitis Quality of Life Instrument; DSMQ
Jung <i>et al</i> [18]	2022	South Korea	Retrospective, single-center study	122	122	12 months	PD	EORTC QLQ-C30; EORTC QLQ-PAN26
Qin <i>et al</i> [27]	2023	China	Prospective, randomized controlled trial	656	200	3 yr	PD	EQ-5D-3L

EORTC: European Organization for Research and Treatment of Cancer; PRE: Preoperative quality of life; PD: Pancreaticoduodenectomy; PPPD: Pylorus-preserving pancreaticoduodenectomy; DPPHR: Duodenum-preserving pancreatic head resection; SF-36: 36-item Short; EQ-5D: European Quality of Life 5-dimension.

term QOL and significantly increased post-operative morbidity and risk than DP or PD[49,50].

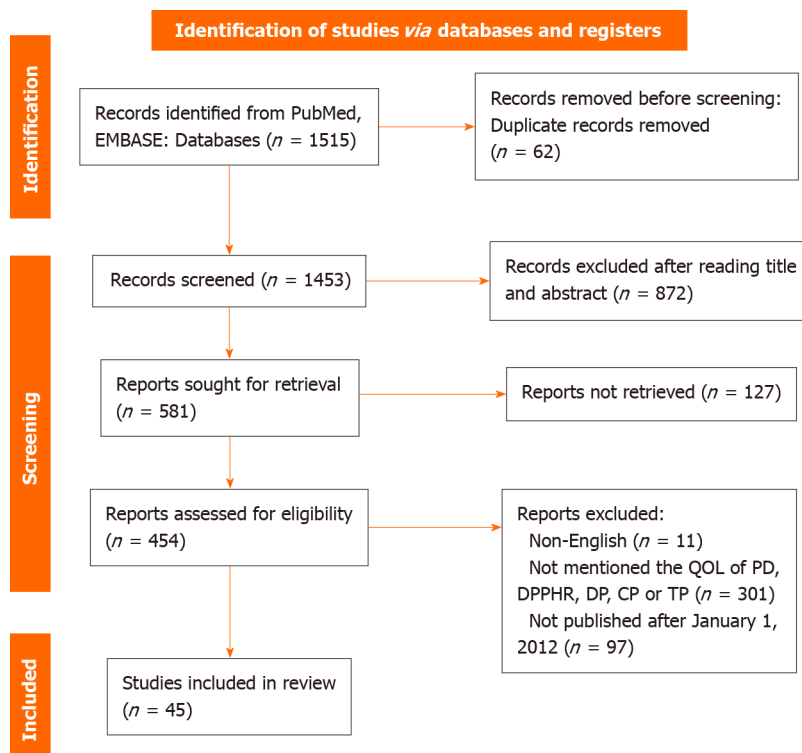
### Study characteristics for TP

The two studies on TP were prospective observational studies (Table 4). Two articles showed the results of QOL within one year. It has been extensively verified that the perioperative and long-term outcomes of TP are comparable to those of PD regarding morbidity, mortality, survival rates, and QOL, regardless of patient age or tumor pathology[51-55]. One study demonstrated that the long-term post-operative QOL of patients who underwent TP was lower than that of the general population[56], however, more studies reported no significant differences[57,58]. Regarding pain relief, especially for most patients with narcotic-dependent, TP could alleviate pain largely such that half of the patients with chronic pancreatitis patients could be relieve from narcotics and return to normal life a year after surgery. However, it is a continuous improvement process. Over time, an increasing number of patients no longer required narcotics to control their abdominal pain[59-63]. More than half of the patients reported that their bowel habits had changed; therefore, they needed to take pancreatin[64-66]. A quarter to more than half of the patients, especially children, achieved insulin independence after islet cell autotransplantation (IAT)[67]. Although the insulin independence rate could decline over time, most patients could almost control their glycemic stability with an acceptable dose of insulin[60,61,68-70]. The stable control of glucose provides a more enjoyable life with better QOL for patients to have a normal social, work and study life [71].

**Table 2** Articles retrieved from literature reporting quality of life after duodenum-preserving pancreatic head resection

Ref.	Year	Country	Study design	Relevant patients	Total patients	Moments of assessment	Operation type	Questionnaires
Bachmann <i>et al</i> [33]	2014	Germany	Randomized controlled trial	74	74	16 (14, 18) yr	DPPHR	EORTC QLQ-C30
Tan <i>et al</i> [35]	2016	China	Retrospective, single-center study	80	156	50 months	The Frey and modified Frey	EORTC QLQ-C30
Pothula <i>et al</i> [81]	2014	India	Prospective single-center study	25	25	PRE, 12 months	The Frey	SF-36
Klaiber <i>et al</i> [32]	2016	Germany	Prospective single-center study	40	65	129 (111, 137) months	The Beger and modified Beger	EORTC QLQ-C30; EORTC QLQ-PAN26
Keck <i>et al</i> [29]	2012	Germany	Prospective, randomized controlled trial	85	85	> 5 yr	The Frey and Beger	EORTC QLQ-C30
Fischer <i>et al</i> [30]	2015	United States	Retrospective, single-center study	17	45	40.7 (23.7, 53.7) months	DPPHR	EORTC QLQ-C30
Aimoto <i>et al</i> [82]	2013	Japan	Retrospective, single-center study	16	16	70.8 months for the Frey, 119.8 months for PPPD	The Frey and PPPD	EORTC QLQ-C30

EORTC: European Organization for Research and Treatment of Cancer; DPPHR: Duodenum-preserving pancreatic head resection; PPPD: Pylorus-preserving pancreaticoduodenectomy; PRE: Preoperative quality of life; SF-36: 36-item Short.



**Figure 1 PRISMA flow diagram.** QOL: Quality of life; PD: Pancreaticoduodenectomy; DPPHR: Duodenum-preserving pancreatic head resection; DP: Distal pancreatectomy; CP: Central pancreatectomy; TP: Total pancreatectomy.

## DISCUSSION

### PD

PD, developed by Kausch[72] and Whipple *et al*[73], is a major surgical procedure used to treat middle and lower-segment cancers of the common bile duct and the periampullary region. The safety of PD has improved significantly in recent years. The mortality rate of PD has decreased from > 50% to < 5%, and the incidence of surgical complications has also decreased significantly[74]. Under these circumstances, attention gradually shifted from safe hospital discharge to



**Table 3** Articles retrieved from literature reporting quality of life after distal pancreatectomy and central pancreatectomy

Ref.	Year	Country	Study design	Relevant patients	Total patients	Moments of assessment	Operation type	Questionnaires
van Hilst <i>et al</i> [38]	2019	Netherlands	Prospective, randomized controlled trial	63	108	1 yr	ODP and LDP	EQ-5D; EORTC QLQ-C30; EORTC QLQ-PAN26
De Rooij <i>et al</i> [36]	2019	Netherlands	Multicenter, randomized controlled trial	108	111	From postoperative day 3 to 30	ODP and MIDP	EQ-5D-3L; EORTC QLQ-C30
Korrel <i>et al</i> [40]	2021	Netherlands	Multicenter, randomized controlled trial	62	84	44 (39, 50) months	ODP and MIDP	EQ-5D; EORTC QLQ-C30; EORTC QLQ-PAN26
Zhang <i>et al</i> [44]	2021	China	Retrospective, single-center study	102	110	106 (62, 189) months	LSPDP and LDPS	SF-36
Ricci <i>et al</i> [41]	2015	Italy	Retrospective, single-center study	54	81	12 months	ODP and LDP	EORTC QLQ-C30
De Pastena <i>et al</i> [42]	2021	Italy	Multicenter, randomized controlled trial	79	152	52 months	LDP and RDP	EQ-5D; EORTC QLQ-C30
Choi <i>et al</i> [45]	2012	Korea	Retrospective, single-center study	61	72	23 (3, 76) months	LSPDP and LDPS	-
Braga <i>et al</i> [39]	2015	Italy	Retrospective, single-center study	100	170	1 and 3 months	LDP	SF-8
Kwon <i>et al</i> [43]	2016	Korea	Retrospective analysis of prospective gathered data, single-center	104	111	PRE, at discharge, 3, 6 and 12 months	LSPDP and LDPS	EORTC QLQ-C30
Zhang <i>et al</i> [47]	2017	China	Retrospective, single-center study	36	36	45 (4, 216) months	LCP and OCP	SF-36
Lv <i>et al</i> [50]	2018	China	Retrospective, single-center study	42	42	53 (21, 117) months	CP and DP	EORTC QLQ-C30

EORTC: European Organization for Research and Treatment of Cancer; ODP: Open distal pancreatectomy; LDP: Laparoscopic distal pancreatectomy; MIDP: Minimally invasive distal pancreatectomy; LSPDP: Laparoscopic spleen-preserving distal pancreatectomy; LDPS: Laparoscopic distal pancreatectomy with splenectomy; RDP: Robotic distal pancreatectomy; LCP: Laparoscopic central pancreatectomy; OCP: Open central pancreatectomy; PRE: Preoperative quality of life; SF-36: 36-item Short; EQ-5D: European Quality of Life 5-dimension.

the recovery of QOL. Therefore, an increasing number of studies have assessed the changes in patients' QOL after PD. However, these studies came from different countries with different demographic characteristics and almost always had small sample sizes, especially prospective studies. As shown in Table 1, seven of the studies had a sample size of < 100 participants, and only one had a sample size of more than 300.

PPPD was first performed in 1943 by Watson[75] and was popularized by Traverso and Longmire[76]. Although the merits of PPPD versus classic PD are still debated, especially regarding perioperative risk, PPPD provides surgeons with another option[77]. Most studies have demonstrated that PPPD and PD have similar effects on patients' QOL. Factors leading to the delayed recovery of QOL, such as preoperative body weight loss and impaired preoperative pancreatic exocrine function, are currently being explored.

Traditionally, PD was performed openly. Since the first case described by Gagner and Pomp[78] in 1994, many surgeons have explored the advantages of LPD and open PD (OPD). Our previous multi-center, open-label, RCT proved that LPD was associated with a shorter length of stay, similar short-term morbidity, and mortality rates as OPD. Due to the better safety of LPD and the maturity of surgical techniques, an increasing number of surgeons are focusing on comparing the differences in QOL between LPD and OPD. LPD have a better QOL advantage than OPD in the first six months, however, our new study showed that this advantage disappears three years postoperatively[27]. However, owing to the difficulty in collecting data, most related research data are unrepresentative. Therefore, high-quality RCTs should be performed in the future.

### DPPHR

PD was surgeons' first choice for benign or low-grade malignant lesions of the pancreatic head until the emergence of DPPHR. For these patients, since Beger *et al*[79] developed DPPHR in the early 1970s, another choice has emerged; with DPPHR, more organs are preserved, which could result in better endocrine and exocrine function postoperatively. Therefore, many studies have focused on prioritizing PD and DPPHR. Except for the perioperative parameters, whether DPPHR is superior to PD regarding QOL is still controversial[80]. Most researchers believe that DPPHR and PD relieve

Table 4 Articles retrieved from literature reporting quality of life after total pancreatectomy

Ref.	Year	Country	Study design	Relevant patients	Total patients	Moments of assessment	Operation type	Questionnaires
Wilson <i>et al</i> [61]	2014	United States	Retrospective, single-center study	112	166	At least 5 yr (60 to 132 months)	TPIAT	SF-36
Pulvirenti <i>et al</i> [54]	2019	Italy and United States	Retrospective, multicenter study	94	329	63 (20, 109) months	TP	SF-36; EORTC QLQ-PAN26
Hartwig <i>et al</i> [57]	2015	Germany	Retrospective, single-center study	81	434	24, 48, 72, 96 and 120 months	TP	EORTC QLQ-C30; EORTC QLQ-PAN26
Chinnakotla <i>et al</i> [70]	2014	United States	Retrospective, single-center study	30	75	PRE, 3, 6, 12 months and annually post-operative	TPIAT for children	Rand-36
Stoop <i>et al</i> [64]	2020	Netherlands	Retrospective, single-center study	53	145	21 (13, 54) months	TP	EORTC QLQ-C30; EORTC QLQ-PAN26; Problem Areas in Diabetes; Diabetes Treatment Satisfaction Questionnaire
Chinnakotla <i>et al</i> [60]	2014	United States	Retrospective analysis of prospective gathered data, single-center	80	484	3, 6, 12 and 24 months	TPIAT	RAND-36
Bellin <i>et al</i> [67]	2015	United States	Retrospective, single-center study	> 100	> 100	12, 24 and 36 months	TPIAT for children	SF-36
Wu <i>et al</i> [65]	2016	China	Retrospective, single-center study	36	186	5.9 yr	TP	SF-36; Audit of Diabetes Dependent QoL; EORTC QLQ-PAN26
Watanabe <i>et al</i> [58]	2015	Japan	Retrospective, single-center study	25	44	21 (2, 222) months	TP	SF-36
Walsh <i>et al</i> [62]	2012	United States	Prospective single-center study	20	20	12 (6.75, 24) months	TPIAT	Visual Analogue Pain Scale; 20 Point Depression Anxiety Stress Scale; 10-point Pain Disability Index
Scholten <i>et al</i> [53]	2019	Netherlands	Retrospective, multicenter study	60	148	3 and 5 yr	TP	EQ-5D; EORTC QLQ-C30
Casadei <i>et al</i> [56]	2016	Italy	Prospective single-center study	119	257	TP 28 (18, 36) months, PD 27 (14, 27) months	TP and PD	EQ-5D-5L
Barbier <i>et al</i> [66]	2013	United States	Retrospective, single-center study	25	56	35 (4, 168) months	TP	EORTC QLQ-C30; EORTC QLQ-PAN26
Solomina <i>et al</i> [71]	2017	United States	Retrospective analysis of prospective gathered data, single-center	20	20	28 (2, 38) months	TPIAT	SF-36

TPIAT: Total pancreatectomy and islet cell auto-transplantation; PRE: Preoperative quality of life; EORTC: European Organization for Research and Treatment of Cancer; SF-36: 36-item Short; EQ-5D: European Quality of Life 5-dimension; TP: Total pancreatectomy.

obstruction of the pancreatic head, which was the cause of the symptoms. Therefore, they have no significant influence on long-term QOL postoperatively[28,29]. Another study also suggested that increased digestive tract reconstruction during PD surgery lead to lower exocrine function and worse QOL postoperatively[31]. However, this study had poor representativeness because of its smaller sample size and earlier publication time.

Modifications of the original Beger procedure appeared, such as those by Frey and Berne, as people realized its superiority[81,82]. Compared to the Beger, Frey and Berne were technically more straightforward. All patients maintained the same pancreatic volume and exocrine and endocrine functions. Therefore, they had advantages regarding operation time and duration of hospital stay but showed no noticeable difference in improving postoperative QOL[32-35]. In conclusion, surgeons can choose any of them based on their expertise and intraoperative findings. Owing to the shorter operation time and length of hospital stay, modifications to the original Beger procedure should be preferred.

## DP

DP is the standard surgical method for treating tumors of the pancreatic body or tail. Traditionally, it has been performed using an open approach. However, due to technological developments in laparoscopic and robotic instruments, MIDP is routinely performed by surgeons worldwide. Nearly all studies have demonstrated that MIDP can result in better QOL

than ODP perioperatively. However, which is better in the long-term remains controversial. Larger sample sizes and more convincing studies have reported no long-term differences between MIDP and ODP[38,40].

While performing DP, the traditional approach is to remove the spleen because it is closely attached to the distal pancreas anatomically. As people realize the function of the spleen, an increasing number of surgeons are choosing to perform LSPDP for benign and low-malignancy tumors of the distal pancreas. Due to the preservation of the spleen in LSPDP, it is clear that LSPDP is superior to LDPs regarding QOL[44,45].

Appleby surgery was first performed in 1976 for the treatment of progressive carcinoma[83] of pancreatic body and tail. Owing to the difficulty of Appleby technology and the advent of neoadjuvant therapy, the number of Appleby surgeries is decreasing; therefore, there is a lack of relevant studies concerning QOL after Appleby.

## CP

Guillemin successfully performed CP by anastomosis to both pancreatic remnants with an omega-shaped jejunal loop in 1957[84]. Letton and Wilson[85] completed the procedure in two patients with pancreatic injury with a Roux-en-Y jejunal loop anastomosis to the tail and closure to the head remnant[85]. An increasing number of surgeons prefer to perform this procedure in cases where the lesion is limited to the pancreatic neck or body. A normal pancreas has significantly less parenchymal loss, which means that more pancreatic function can be retained. According to previous studies, functional recovery and mean QOL are comparable to those of a standard control population[48]. It is generally believed that patients who underwent CP have a better QOL, but a higher perioperative risk[47-50]. However, studies on the QOL after CP are lacking.

## TP

Since Rockey[86] performed the first TP in a patient with pancreatic cancer in 1942, some surgeons have attempted to perform the same procedure. However, owing to poor perioperative outcomes and QOL in the beginning, the feasibility of TP has been questioned. Many studies have been conducted to answer this question. The safety of TP has improved dramatically owing to mature surgical techniques and other factors. Impaired exocrine function is also one of the reasons why the feasibility of TP has been questioned. However, the optimization of pancreatin improved the patients' exocrine function. Another reason is the high risk of brittle diabetes. Many factors are associated with insulin independence, such as non-hereditary chronic pancreatitis, younger age, lower body surface area, and higher total islet equivalents. The pancreas is the only organ that produces insulin. Due to the removal of the entire pancreas, TP causes great damage to patients' ability to maintain stable blood sugar levels. To solve this problem, a new technology, the IAT, was first described in 1977. In IAT, islet cells are isolated from patients and transplanted into the portal vein. With the advent of pancreatin and IAT, the endocrine and exocrine functions of patients after TP have significantly improved[64-66]. It seems unlikely that TP can maintain or improve patients' QOL. However, this was only possible if the patient had preoperative endocrine and exocrine pancreatic dysfunction or chronic pain. TP improved the QOL of these patients to some extent. In conclusion, TP can be considered in selected patients with neoplasms involving the entire pancreas or refractory chronic pancreatitis, regardless of the age of patients and pathology of the neoplasms.

## CONCLUSION

Due to the importance of the endocrine and exocrine functions of the pancreas, surgeons have attempted to preserve normal pancreatic tissue and surrounding organs. Therefore, different surgical procedures have been developed depending on the location of the neoplasms. However, regardless of the procedure type, perioperative outcomes were generally acceptable. PD and TP had similar effects on patients' QOL. The time that patients needed to recover to the preoperative or baseline level was 3-6 months after PD, but longer after TP. At this stage, more than half of the patients still required pancreatin to relieve gastrointestinal symptoms. Most studies have demonstrated that PPPD has a similar influence on perioperative and long-term outcomes as PD. DPPHR could provide better QOL with less pain, nausea, and diarrhea symptoms, and better physical and working status. In addition, owing to the higher incidence of perioperative complications in CP than in PD, whether CP could provide a better QOL remains debatable. As far as minimally invasive surgery is concerned, it seems that they could indeed produce better QOL in the early stages after PD and DP, but the long-term outcomes still need to be confirmed by more studies. In DP, preservation of the spleen can preserve the immunological function of the patients to defeat the usual virus.

This study has some shortcomings. We did not complete a systematic analysis of the data from previous studies, but only analyzed their conclusions. The scope of our study was not comprehensive enough, and some surgical procedures were not included. However, our goal was to provide directions for future research.

It is so big a project to collect data about patients' postoperative QOL levels that the majority of studies do not have enough cases. It is not easy to contact patients *via* e-mail or phone once they are discharged from hospital. This means that incomplete data are common, especially when collecting long-term outcomes. As shown in the table, the rate of loss to follow-up was high, and there was a lack of prospective studies, especially randomized controlled studies. We propose conducting well-designed prospective analyses to verify our results.



## ARTICLE HIGHLIGHTS

### Research background

Pancreatic surgery is challenging because of the anatomical characteristics of pancreas. With the progress of medical standards, the perioperative outcomes have been greatly improved these years. More and more attention has been paid to the changes of quality of life (QOL) after pancreatic surgery. There is a lack of summary of QOL after various kinds of pancreatic surgery. With the purpose of describing the results of existing researches concerning QOL of pancreatic surgery we conducted this study.

### Research motivation

Understanding which kind of pancreatic surgery has better QOL can provide some basis for clinical surgical decision.

### Research objectives

This review aimed to summarize and analyze current research results on QOL after pancreatic surgery including pancreaticoduodenectomy, duodenum-preserving pancreatic head resection, distal pancreatectomy, central pancreatectomy and total pancreatectomy after January 1, 2012. It provides some directions for future researches based on the results of the controversy over patients' QOL after surgery. And it also provides some basis for clinical surgical decision-making.

### Research methods

A systematic review was conducted in PubMed and EMBASE Database, according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses guideline. And references of the retrieved articles were screened for any relevant articles. We extracted the results of these articles and summarized them.

### Research results

This review summarizes and analyzes current research results on QOL after pancreatic surgery. The article covers the discussion and analysis of the QOL of various pancreatic surgery. Which kind of surgical procedure has better QOL is controversial. The long-term benefits on QOL of minimally invasive surgery over open surgery are controversial.

### Research conclusions

Comparison and summary of QOL in patients with different types of pancreatic surgery. We included not only the results of the same surgical procedure, but also the results between different procedures.

### Research perspectives

More well-designed prospective analyses of patients' QOL after pancreatic surgery are needed.

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**Author contributions:** Li SZ, Zhang H, and Qin RY designed the research; Wu Y and Qin TT analyzed the data; Li SZ and Zhen TT wrote original draft; Wang M and Zhang H reviewed and edited the draft; All authors have read and approve the final manuscript.

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