Meta-Analysis of Observational Studies in Epidemiology

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Effect of polyglycolic acid mesh for prevention of pancreatic fistula after pancreatectomy

A systematic review and meta-analysis

Wei Zhang, MD[a], Zhicheng Wei, MD[b], Xu Che, MD[a,b,*]

Abstract

Postoperative pancreatic fistula (POPF) is the most common and intractable complication after partial pancreatectomy, with an incidence of 13% to 64%. Polyglycolic acid (PGA) mesh is a new technique that is designed to prevent POPF, and its effect has been evaluated in several randomized controlled trials and some retrospective cohort studies. In this study, we systematically and comprehensively analyzed the efficacy of PGA mesh based on reported studies.

We searched Medline, Embase, and Cochrane Library databases in English between January 2010 and October 2019. Analysis was performed by using Review Manger 5.3 software.

Three RCTs and 8 nonrandomized studies were eligible with a total of 1598 patients including 884 PGA group patients and 714 control group patients. For pancreatoduodenectomy (PD), distal pancreatectomy (DP), and the 2 partial pancreatectomy (PD or DP), we found significant statistical differences in overall POPF (relative risk [RR] = 0.75, 95% confidence interval [CI] = 0.61–0.91, P = .004; RR = 0.74, 95% CI = 0.57–0.96, P = .02; RR = 0.76, 95% CI = 0.64–0.89, P = .0009, respectively) and clinical pancreatic fistula (PF) (RR = 0.5, 95% CI = 0.37–0.68, P < .00001; RR = 0.31, 95% CI = 0.21–0.46, P < .00001; RR = 0.41, 95% CI = 0.32–0.52, P < .00001, respectively) in favor of PGA. For partial pancreatectomy, significant statistical differences were found in overall complications (RR = 0.77, 95% CI: 0.67–0.88, P = .0002) and estimated blood loss (weighted mean difference [WMD] = −53.58; 95% CI: −101.20 to −5.97, P = .03) in favor of PGA. We did not find significant differences regarding operative time (WMD = −8.86; 95% CI: −27.59 to 9.87, P = .35) and hospital stay (WMD = −2.73; 95% CI: −7.53 to 2.06, P = .26).

This meta-analysis shows the benefits of the PGA mesh technique regarding POPF, clinical PF, and postoperative complications. This still needs to be verified by more randomized control trials.

Abbreviations: CI = confidence interval, DP = distal pancreatectomy, EBL = estimated blood loss, PD = pancreatoduodenectomy, PF = pancreatic fistula, PGA = polyglycolic acid, POPF = postoperative pancreatic fistula, RCSs = retrospective cohort studies, RCT = randomized controlled trial, RR/WMD = relative risk/weighted mean difference.

Keywords: pancreatectomy, pancreatic fistula, polyethylene glycolic acid, surgical mesh

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The datasets generated during and/or analyzed during the current study are publicly available.

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1. Introduction

In recent years, a partial pancreatectomy has been used more and more in patients with benign and malignant lesions of the pancreas and periampullary area. Postoperative pancreatic fistula (POPF) is the most common and intractable complication after partial pancreatectomy, with an incidence of 13% to 64%.[1–4] Although the development of surgical techniques and lots of new experimental attempts in perioperative management has significantly reduced the mortality of pancreatic surgery,[5] the postoperative complications are still high, reaching 40% to 50%.[6] Leakage of pancreaticojejunostomy or POPF is the major complication after a pancreatectomy. According to the classification of POPF by the International Study Group for Pancreatic Surgery in 2005 and the revision and update of 2017,[2,3] the pancreatic fistula (PF) is classified into grades A, B, and C. Grade A POPF is self-healing and does not require clinical intervention, which is also called biochemical PF, but changes in clinical management or a deviation from the normal clinical path are needed for grade B and grade C POPF. Therefore, grade B or C PF is also called clinical PF now, and from a clinical point of view, it is important to reduce the risk of clinical PF in patients undergoing a pancreatectomy. To prevent POPF, a large number of methods, such as pancreaticojejunostomy, fibrin sealant, pancreatic stent implantation, and octreotide, have been used for a pancreatectomy. However, the incidence of POPF has not decreased significantly. In recent years, polyglycolic acid (PGA) mesh has been introduced, but its effect is still not very clear. At present, there are several prospective randomized controlled trials and some retrospective cohort studies to verify its efficacy. Here, a systematic and comprehensive analysis of the existing literature was performed to evaluate the role of PGA mesh in reducing POPF from an evidence-based perspective.

2. Methods

2.1. Search strategy

We conducted a literature search of the EMBASE, PubMed, and Cochrane Library databases to identify relevant available articles published in English between January 2010 and October 2019. The search terms included "polyglycolic acid mesh," "surgical mesh," "stapler," "reinforce," "pancreatic fistula," "pancreatectomy," and "pancreaticoduodenectomy". We also reviewed the reference lists of the included studies for undetected relevant studies. We contacted the original authors to obtain extra information if needed.

2.2. Inclusion criteria

The inclusion criteria were as follows: original research from observational studies or randomized controlled trials (RCTs) in adults, the interventions of interest were present or absent regardless of PGA mesh, the total sample size was >50 and each arm was not <15, the participants of interest were patients suffering from pancreatic surgery, and the most recent and complete study was included if the data from the same population had been published more than once.

2.3. Data extraction and quality assessment

Documents meeting the following conditions were excluded:

1. Literature with incomplete information, the inability to extract effective data, unresponsive contact with the author, a repeated publication, and unpublished or unclear classification of PF.
2. Studies that reported outcomes only after wrapping PGA mesh around the anastomotic site alone without comparison.
3. Literature written in languages other than English.
4. Review studies, case reports, or animal experiments.

This meta-analysis included RCTs[7–9] and retrospective cohort studies (RCSs).[10–17] In all the studies that were included, RCTs were assessed according to the "risk assessment tool" recommended by the Cochrane collaborative network, including whether they were correctly allocated randomly, there was a hidden scheme for allocation, they used the blind method, they described the loss of access and withdrawal, and they conducted intention analysis in case of loss of access or withdrawal. RCSs were assessed according to the Newcastle Ottawa scale (NOS), including study population selection, comparability, exposure evaluation, or outcome evaluation. NOS adopts the semiquantitative principle of a star system to evaluate the quality of retrospective research literature, with a full score of 9 stars.

2.4. Statistical analysis

The review manger 5.3 software was used for meta-analysis. For binary data and continuous data, the relative risk (RR), weighted mean difference (WMD), and 95% confidence interval (CI) were respectively used to represent the combined statistics. Heterogeneity among the included studies was qualitatively evaluated using a χ^2 based Q test. P values <.05 showed that there was statistically significant heterogeneity across the studies. The level of heterogeneity between studies was evaluated using I^2 statistics. $I^2 < 30\%$ was considered to be low heterogeneity, and a fixed-effects model was applied; $30\% \leq I^2 \leq 60\%$ was considered to be moderate heterogeneity; and $I^2 > 60\%$ represented high heterogeneity. A random-effects model was applied when $I^2 \geq 30\%$. Sensitivity analysis was performed by removing 1 study at a time to assess whether the results could have been markedly affected by a single study. The publication bias was assessed using funnel plots.

3. Results

3.1. Search results and study characteristics

Eleven articles were included in this study. The flow chart of literature screening is shown in Figure 1. Three publications[7–9] were RCTs and 8[10–17] were RCSs, with a total sample size of 1598 patients, including 884 in the PGA group and 714 in the control group. Meta-analysis results of all available studies in measured outcomes are shown in Table 1. The forest map and Table 2 show the basic characteristics and quality evaluation of the documents that were included.

3.2. Overall POPF

Ten studies[7–12,14–17] reported overall POPF, 2 studies[8,15] reported that PGA mesh decreased the incidence of POPF, and 8 studies reported no significant association.[7,9–12,14,16,17] Moderate heterogeneity ($I^2 = 35\%$, $P = .13$) was detected, so we chose a random-effect model to pool the data (RR = 0.76, 95% CI = 0.64–0.89, $P = .0009$). Overall, the pooled data demonstrated

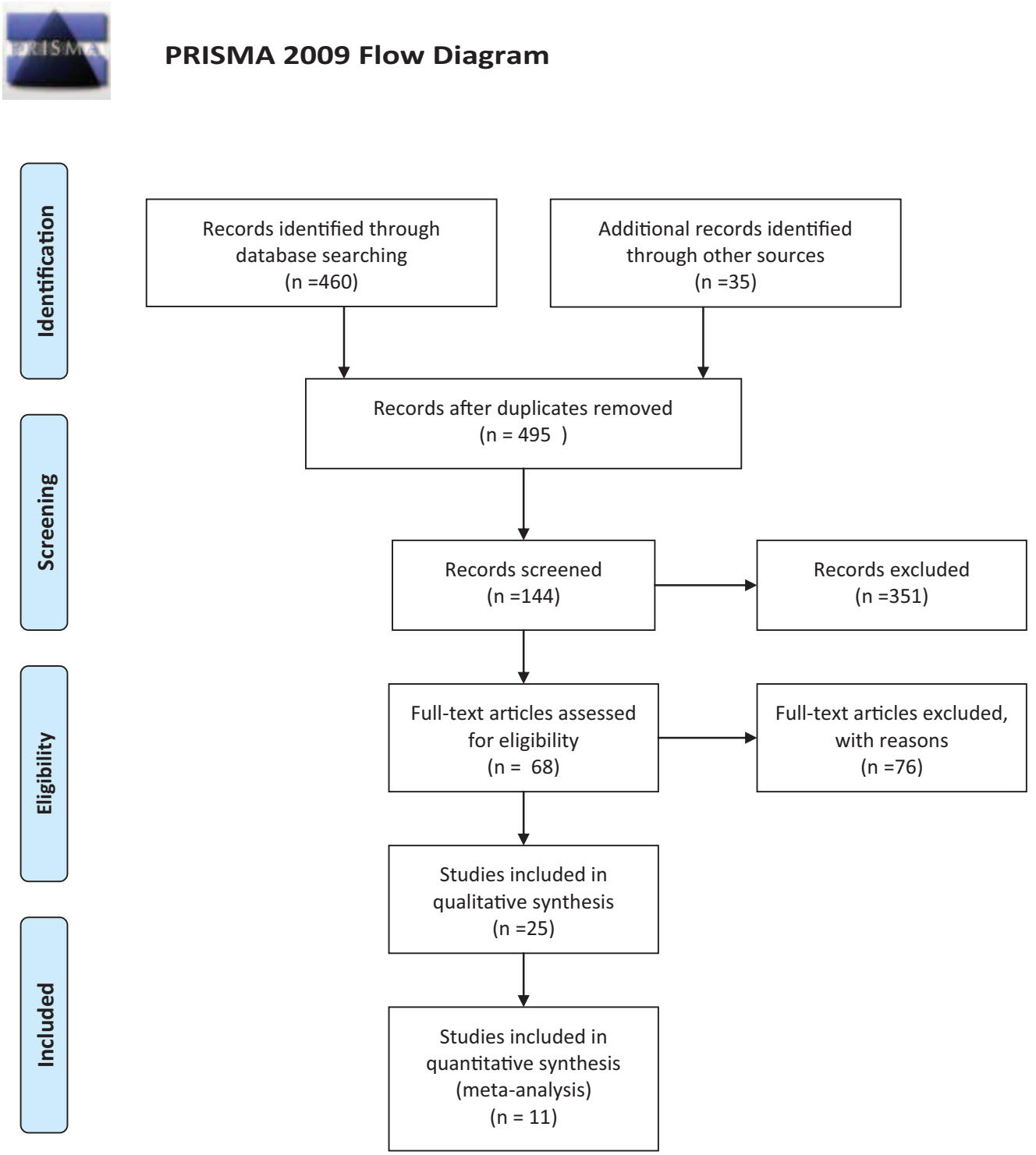

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Figure 1. PRISMA 2009 flow diagram of literature screening.

Table 1

Meta-analysis results of all available studies in measured outcomes.

Measured Outcomes	Subgroup	No. Studies	Heterogeneity test I^2 (%)	Heterogeneity test *P*	Mode	RR/MD	95% Confidence Interval	*P*
POPF	PD	4	0	0.7	Fixed	0.75	0.61 to 0.91	.004
	DP	7	54	0.04	Random	0.74	0.57 to 0.96	.02
	All	10	35	0.13	Random	0.76	0.64 to 0.89	.0009
Clinical POPF	PD	5	0	0.51	Fixed	0.5	0.37 to 0.68	<.00001
	DP	6	28	0.23	Fixed	0.31	0.21 to 0.46	<.00001
	All	10	22	0.24	Fixed	0.41	0.32 to 0.52	<.00001
Grade A POPF	PD	4	54	0.09	Random	1.06	0.65 to 1.72	.81
	DP	6	0	0.44	Fixed	1.35	1.04 to 1.75	.02
	All	9	31	0.17	Random	1.2	0.94 to 1.54	.14
Operation time	ALL	5	66	0.02	Random	−8.86	−27.59 to 9.87	.35
EBL	ALL	5	1	0.4	Fixed	−53.58	−101.2 to 5.97	.03
Hospital stay	ALL	3	84	0	Fixed	−2.73	−7.53 to 2.06	.26
Complication	ALL	5	14	0.32	Fixed	0.77	0.67 to 0.88	.0002
After DP								
POPF	RCs	4	0	0.66	Fixed	0.58	0.44 to 0.77	.0001
	RCT	3	61	0.08	Random	0.89	0.64 to 1.23	.48
Clinical POPF	RCs	3	0	0.56	Fixed	0.25	0.14 to 0.44	<.00001
	RCT	3	50	0.14	Random	0.38	0.16 to 0.91	.03
Grade A POPF	RCs	3	0	0.92	Fixed	1.46	0.88 to 2.4	.14
	RCT	3	56	0.1	Random	1.31	0.97 to 1.76	.08

DP = distal pancreatectomy, EBL = estimated blood loss, No = number of studies, PD = pancreatoduodenectomy, POPF = postoperative pancreatic fistula, RCS = retrospective cohort study, RCT = randomized controlled trial, RR /MD = relative risk/mean difference.

that the POPF in the PGA group was significantly lower than the control group. By analyzing the sources of heterogeneity, we found that the heterogeneity was not significantly reduced after the literature was gradually eliminated. By subgroup analysis, we found that after PD and distal pancreatectomy (DP), the POPF in the PGA group was significantly lower than that in the control group, RR and 95% CI were: $RR_{PD} = 0.76$, 95% CI 0.62–0.92; and $RR_{DP} = 0.74$, 95% CI 0.57–0.96, respectively (Fig. 2).

Table 2

The basic characteristics and quality evaluation of the documents that were included.

Study	Type	Country	Group	Surgery	Case	Age	Sex (m/f)	POPF (total)	Grade A	Grade B C	Quality
Hayashibe and Ogino, 2016[10]	RCS	Japan	Reinforced	DP	29	72.6±10.3	9/20	2	2	0	6
			Control		22	63.0±17.8	9/13	5	1	4	
Hamilton et al, 2012[7]	RCT	USA	Reinforced	DP	54	57.5±15.6	20/34	21	20	1	*
			Control		46	58.6±13.4	25/21	26	15	11	
Jang et al,2017[8]	RCT	Korea	PGA mesh	DP	44	59.9±12	19/25	29	24	5	*
			Control		53	54.5±14.1	20/33	29	14	15	
Kang et al, 2017[11]	PSM	Korea	PGA mesh	PD	281	63.4±10.2	175/106	76	37	39	6
			Control		183	62.4±9.7	116/67	68	24	44	
Kwon et al, 2019[13]	RCS	Korea	Neoveil	PD	84	69.15±10.94	48/36	NA	NA	12	6
			Control		43	66.42±11.87	30/13	NA	NA	16	
Kuramoto et al, 2013[12]	RCS	Korea	PGA mesh	PD	31	63.1±9.1	18/13	9	7	2	7
			Control		33	67.4±7.5	9/24	16	11	5	
Ochiai et al, 2010[14]	RCS	Japan	PGA and fibrin	PD	18	≥60 15 case	NA	10	9	1	6
			Control		36	≥60 28 case	NA	21	7	14	
			PGA and fibrin	DP	26	≥60 14 case	NA	11	10	1	
			Control		37	≥60 22 case	NA	21	11	10	
Pulvirenti et al, 2019[15]	PSM	Italy	Reinforced	DP	92	58 (46–68)	53/38	11	0	11	8
			Control		92	55 (46–67)	38/54	37	0	37	
Satoi et al, 2011[16]	RCS	Japan	PGA and fibrin	PD	50	66 (33_82)	31/19	17	12	5	7
			Control		78	66 (36–90)	51/27	34	23	11	
Yoshino et al, 2019[17]	RCS	Japan	PGA and fibrin	DP	114	NA	NA	15	NA	NA	7
			Control		32	NA	NA	11	NA	NA	
Kondo et al, 2019[9]	RCT	Japan	Reinforced	DP	61	70 (62–76)	31/30	30	20	10	*
			Control		59	73 (67–78)	25/34	36	20	16	

RCS = retrospective cohort studies, RCT = randomized controlled trial, PMA = Propensity matched analysis, NA = not available, PD = pancreatoduodenectomy, DP = distal pancreatectomy.
* Not applicable.

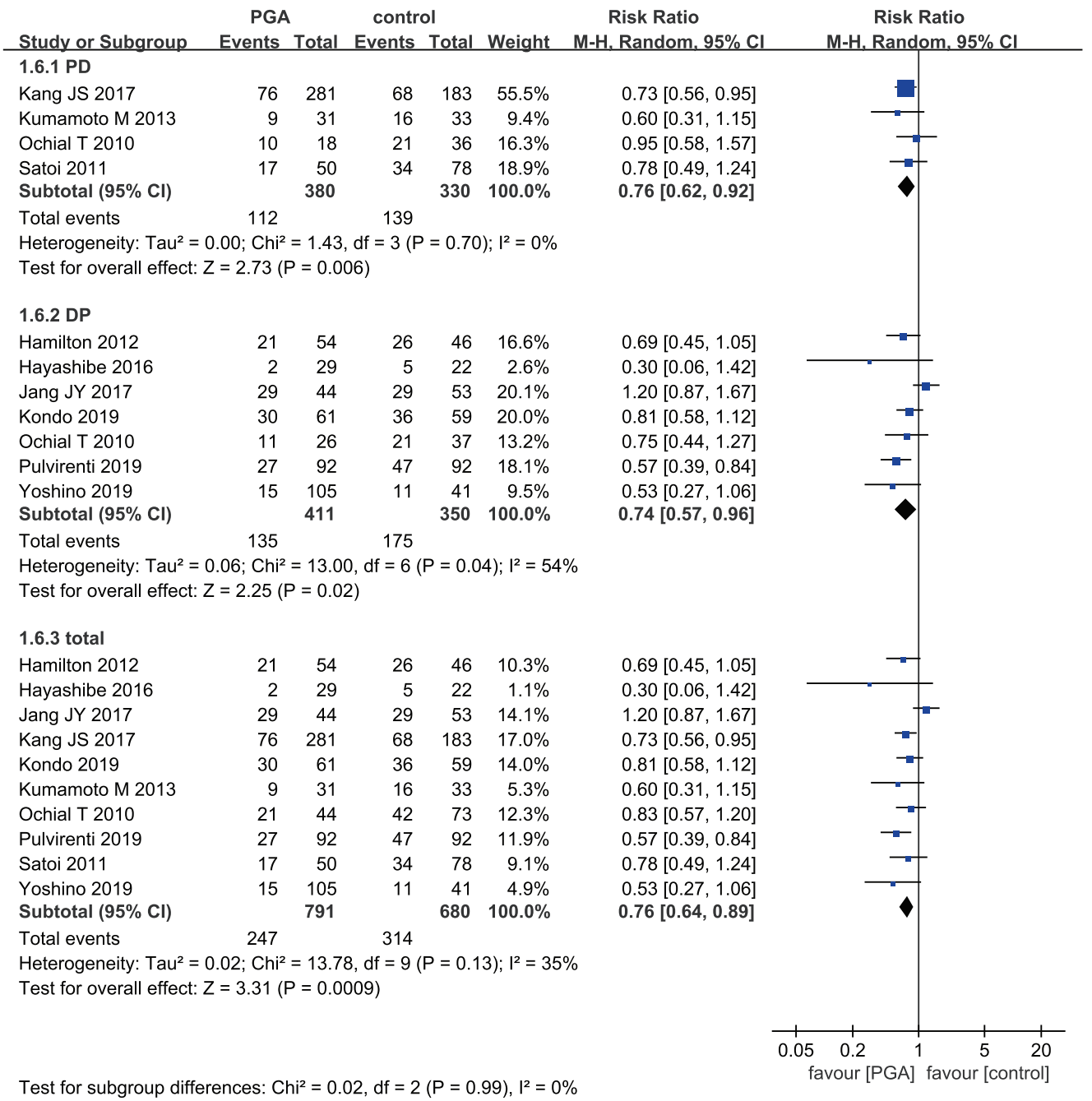


Figure 2. The forest map of overall postoperative pancreatic fistula. CI = confidence interval, DP = distal pancreatectomy, PD = pancreatoduodenectomy, PGA = polyglycolic acid.

3.3. Biochemical POPF

Eight studies[7–12,14–16] reported biochemical POPF. Moderate heterogeneity was detected in these studies (heterogeneity test $I^2 = 31\%$, $P = .17$). Therefore, the random-effect model was used for the combined effect *RR*, (RR = 1.20; 95% CI 0.94–1.54, $P = .14$), with no statistical significance. By analyzing the sources of heterogeneity, we found that the heterogeneity was not significantly reduced after the literature was gradually eliminated. After analyzing each subgroup, it was found that after DP, biochemical POPF was higher than that of the control group, with statistical significance ($RR_{DP} = 1.34$, 95% CI 1.04–1.74). After PD, there was no significant difference between the PGA group and the control group ($RR_{PD} = 1.06$, 95% CI 0.65–1.72) (*supplemental file 1*, http://links.lww.com/MD/E620).

3.4. Clinical POPF

Ten studies[7–16] reported clinical POPF. Low heterogeneity was detected in these studies (heterogeneity test $I^2 = 22\%$, $P = .24$). Therefore, the fixed-effect model was adopted for the combined effect RR (RR = 0.41; 95% CI = 0.32–0.52, $P < .00001$). The clinical POPF in the PGA group was significantly lower than that

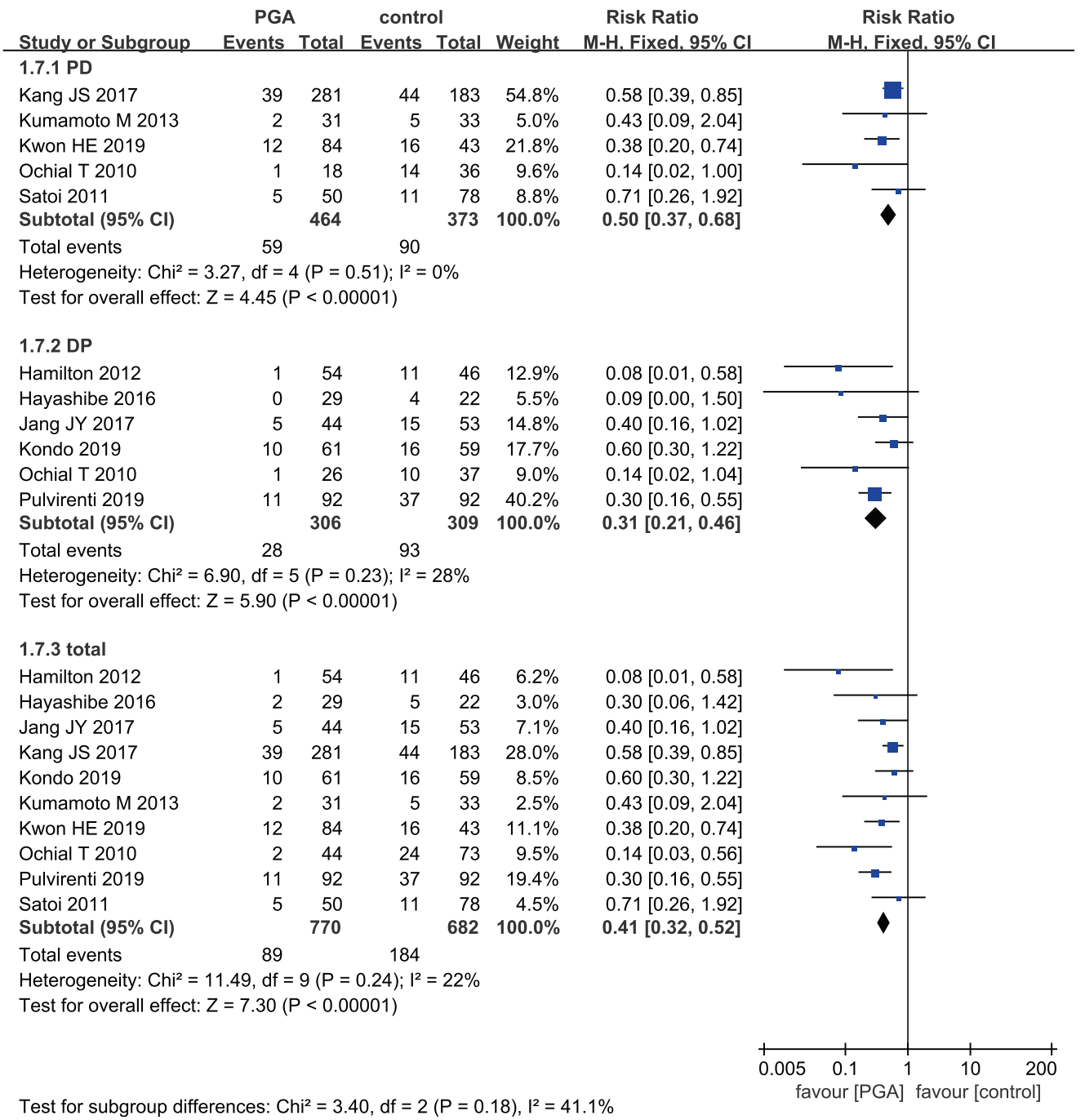
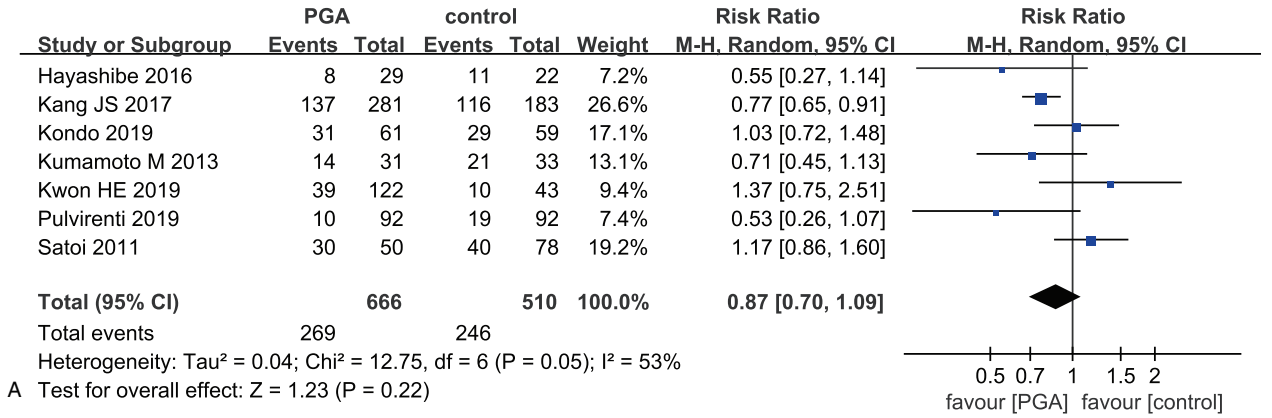


Figure 3. The forest map of grade B and C POPF. CI = confidence interval, DP = distal pancreatectomy, PD = pancreatoduodenectomy, PGA = polyglycolic acid.

in the control group. Subgroup analysis showed that after PD and DP, the incidence of clinical POPF of the PGA group was significantly lower than that of the control group; RR and 95% CI were $RR_{PD}=0.50$, 95% CI 0.37–0.68; $RR_{DP}=0.31$, 95% CI 0.21–0.46, respectively (Fig. 3).

3.5. Complications

Seven studies[9–13,15,16] reported postoperative complications. The standards of complications reported in each study were inconsistent. In this article, we included all available complication data above a level 3 according to the Clavien-Dindo system classification. Sensitivity analysis was then carried out, and the literature was gradually eliminated to reduce the heterogeneity. Moderate heterogeneity was detected between these studies[9–12,15] (heterogeneity test $I^2=53\%$, $P=.05$). After using the random-effect model, it was suggested that there was no significant difference (RR = 0.87; 95% CI 0.70–1.09, $P=.22$). After sensitivity analysis, the heterogeneity between the studies was significantly reduced and the fixed-effect model was used,



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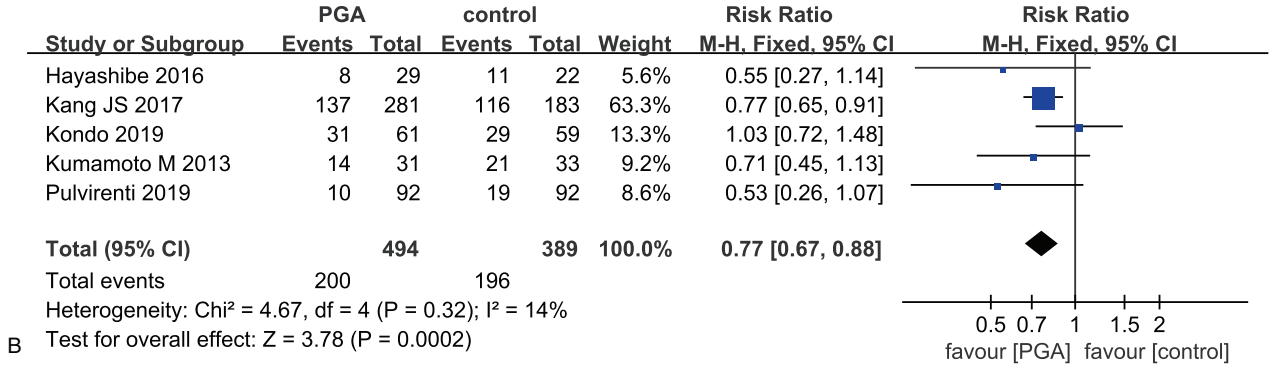

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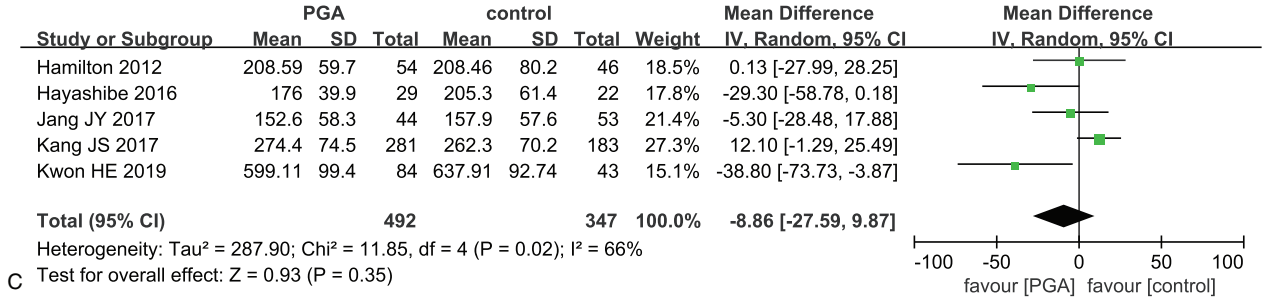

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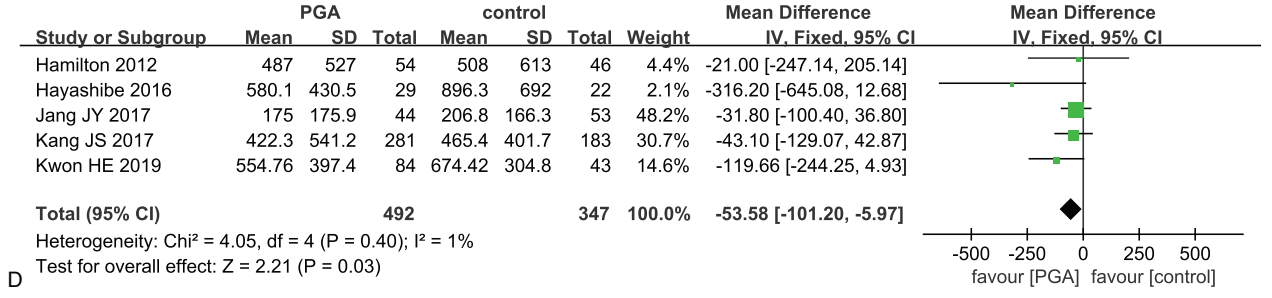

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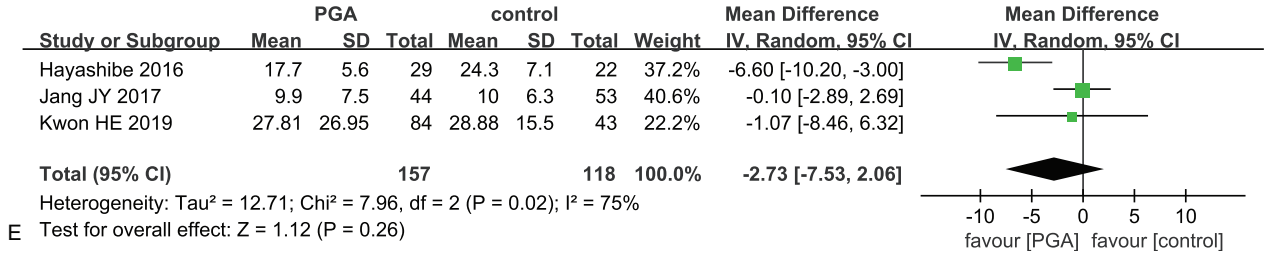

E

Figure 4. The forest maps of meta-analysis. (A) Complication of before sensitivity analysis. (B) Complication of after sensitivity analysis. (C) Duration of surgery. (D) Estimated intraoperative bleeding. (E) Hospital stay. CI = confidence interval, DP = distal pancreatectomy, PD = pancreatoduodenectomy, PGA = polyglycolic acid.

and the complications of the PGA group were significantly lower than that of the control group (RR = 0.77, 95% CI 0.67–0.88, $P = .0002$) (Fig. 4A and B).

3.6. Operation time

Five studies[7,8,10,11,13] reported the operation time. Moderate heterogeneity was detected in these studies (heterogeneity test $I^2 = 66\%$, $P = .02$). Therefore, the random-effect model was adopted for the combined effect (WMD = −8.86; 95% CI −27.59 to 9.87, $P = .35$). There was no significant difference in the operation time between the PGA group and the control group (Fig. 4C).

3.7. Intraoperative bleeding

Five studies[7,8,10,11,13] reported intraoperative bleeding. Low heterogeneity was detected in these studies (heterogeneity test $I^2 = 1\%$, $P = .40$). Therefore, the fixed-effect model was adopted for the combined effect amount of WMD (WMD = −53.58; 95% CI −101.20 to 5.97, $P = .03$). The difference in the PGA group was statistically significantly less than that in the control group (Fig. 4D).

3.8. Hospital stay

Three studies[8,10,13] reported the length of hospital stay. No heterogeneity was detected in these studies (heterogeneity test $I^2 = 0\%$, $P = .84$). Therefore, the fixed-effect model was used for the combined effect of WMD (WMD = −2.73; 95% CI −7.53 to 2.06, $P = .26$). There was no significant difference in intraoperative blood loss between the PGA group and the control group (Fig. 4E).

3.9. Sensitivity analysis and subgroup analysis

For each meta-analysis, sensitivity analysis was performed. For postoperative complications, except for the significantly reduced heterogeneity when literature was gradually removed, the rest of the results were stable. Sensitivity analysis showed that most of the data in this meta-analysis were relatively stable. Since the enrolled literature included RCTs and RCSs, and the 3 RCTs that included were about DP, the incidence of POPF on DP was analyzed by a randomized comparable trial and retrospective controlled trial. (Fig. 5/Fig. 6) (*grade A* PF *after DP are showed as Supplemental file 2*, http://links.lww.com/MD/E621*)*

3.10. Assessment of risk of bias

The analysis of the overall POPF funnel, clinical, and biochemical PF showed that their publication bias was very small because the points on the funnel were basically symmetrical. Due to the small number of studies, the funnel charts for operation time, intraoperative bleeding, and length of hospital stay were not generated (Fig. 7).

4. Discussion

Partial pancreatectomy is the main treatment for benign and malignant lesions of the body and tail of the pancreas and the

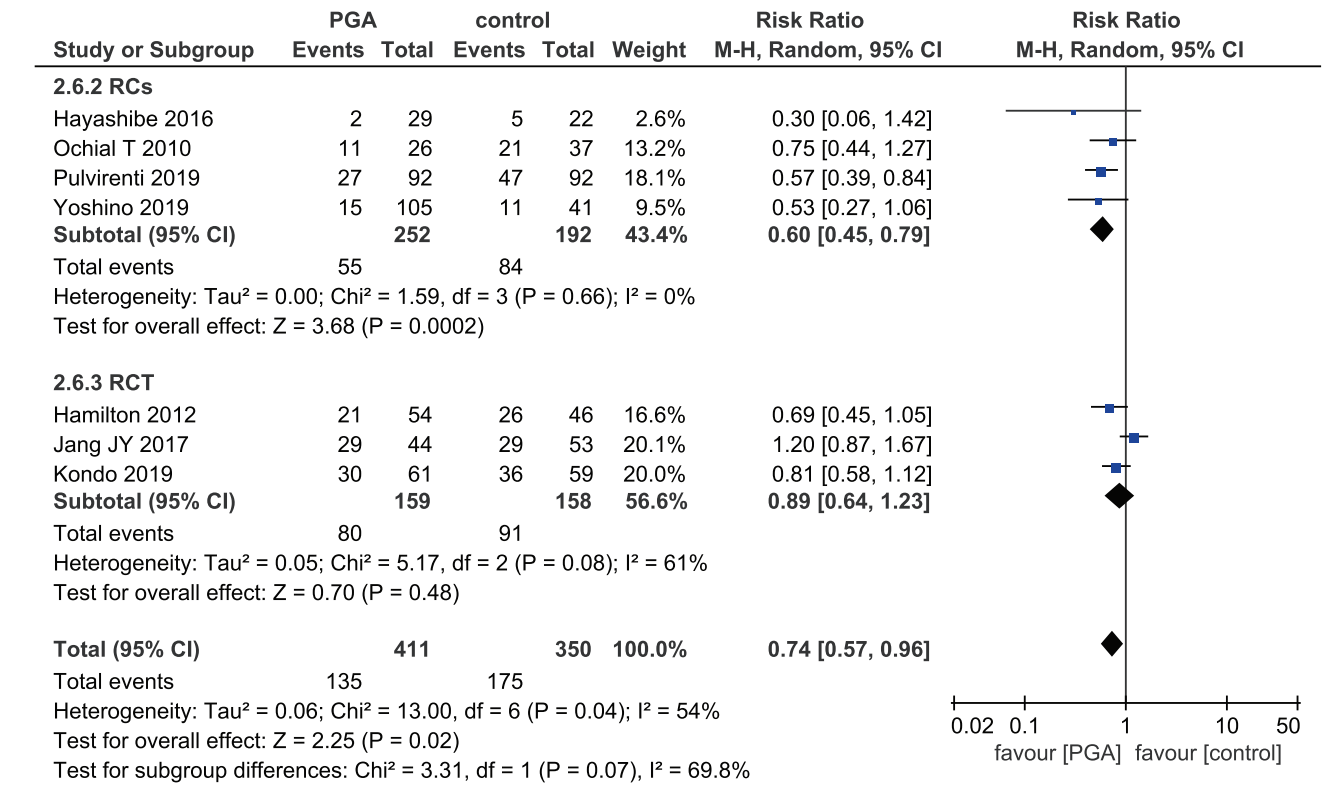

Figure 5. The forest map of overall postoperative pancreatic fistula after DP. CI = confidence interval, DP = distal pancreatectomy, PD = pancreatoduodenectomy, PGA = polyglycolic acid.

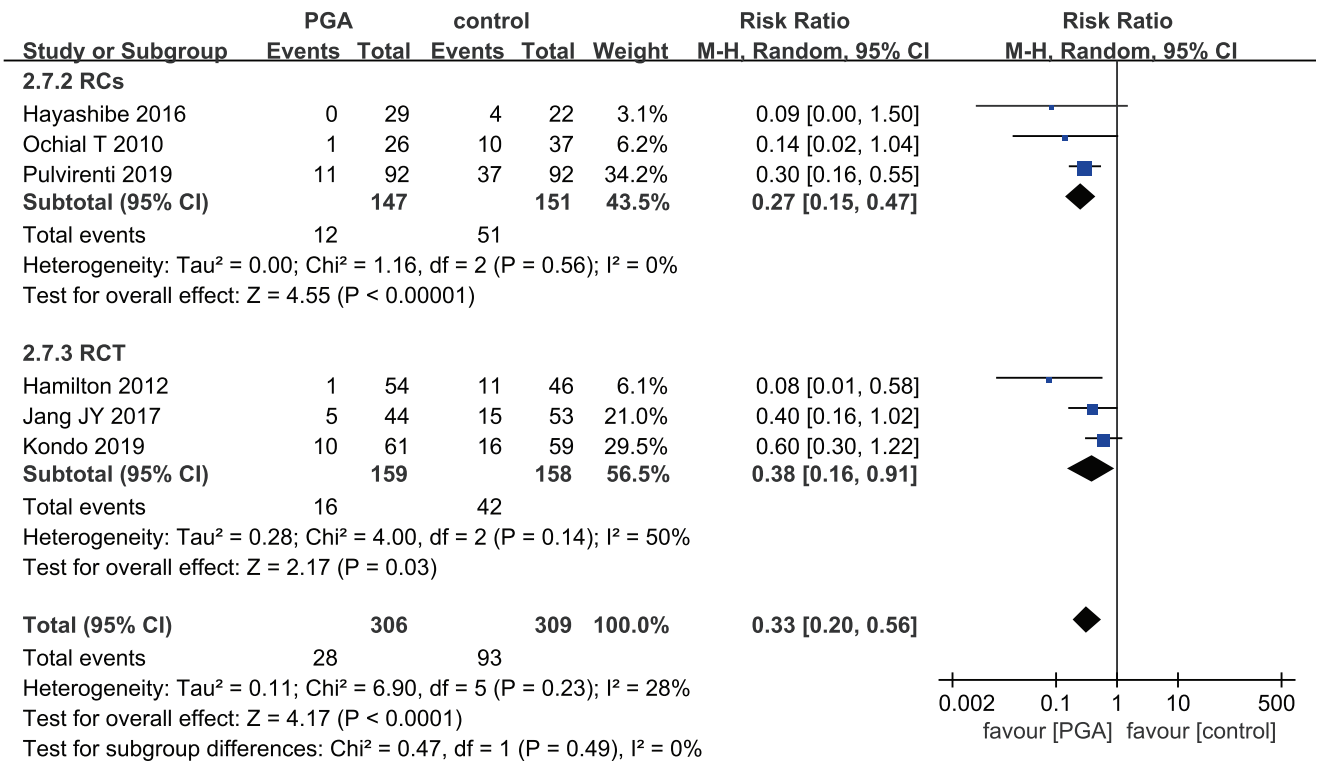

Figure 6. The forest map of grade B and C POPF after DP. CI = confidence interval, DP = distal pancreatectomy, PD = pancreatoduodenectomy, PGA = polyglycolic acid.

local area around the ampulla. With pancreatic surgery, 40% to 50% of patients will experience postoperative complications, and POPF is still the fatal weakness of pancreatic surgery. PF is the most common and induced factor of other complications.[18] Although great efforts have been made in the past decade, no single technology has been able to reduce the risk of PF simply and effectively. At present, the methods to prevent POPF after partial pancreatectomy include a stapling machine, fibrin sealant,

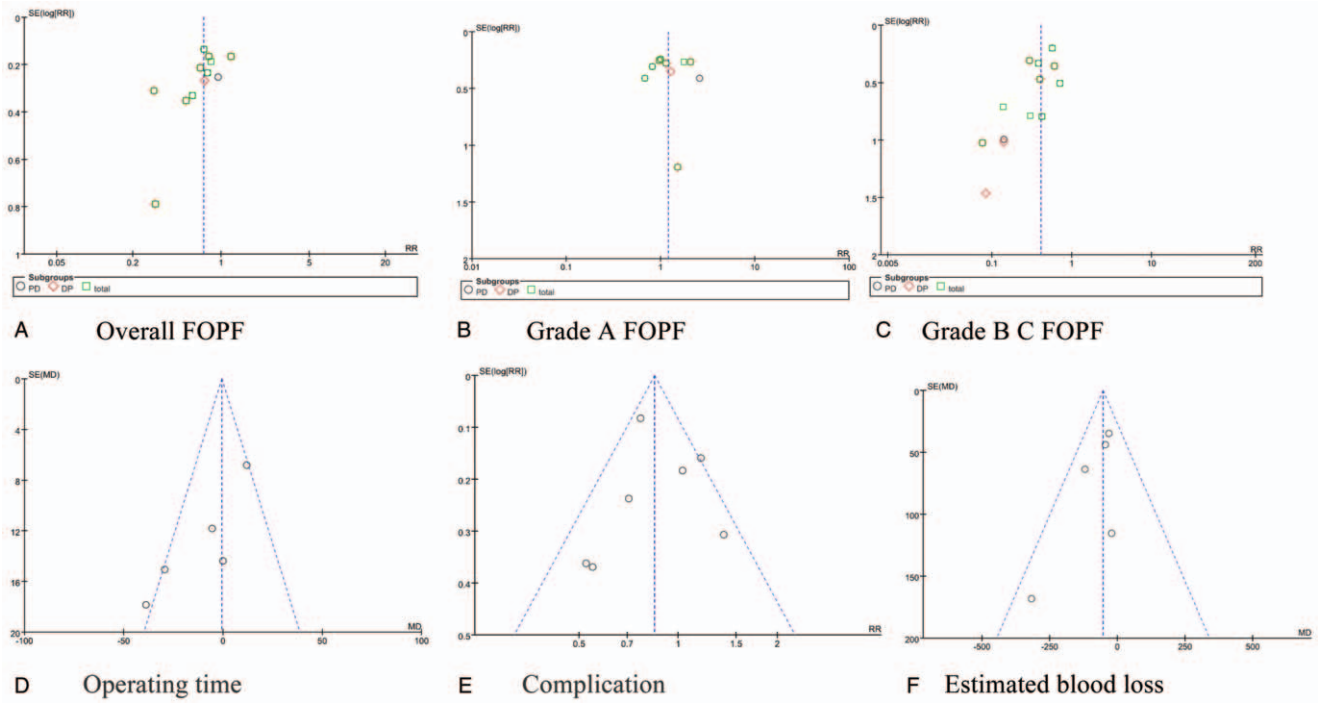

Figure 7. Funnel plots. POPF = postoperative pancreatic fistula.

an autogenous patch, and drug therapy. However, studies have shown that the use of fibrin sealant or an autogenous patch does not reduce the incidence of POPF and complications of pancreaticojejunostomy after PD.[19,20] Drug therapy can effectively reduce the incidence of POPF, but it is extremely expensive.[21] PGA mesh is a common material in the operating room, such as PGA silk line. Many manufacturers specifically make it into mesh because of its high strength, and it can be absorbed and degraded in vivo. It has been successfully used as a repair material for abdominal wall defects, dura mater repair, and lung injury.[22–24] In recent years, PGA mesh has been introduced to prevent POPF after DP.

Some studies have revealed the physiological and pathological reaction of PGA mesh in the human body. When the PGA mesh is put into human body, it will immediately cause an inflammatory reaction. It will be infiltrated by granulation tissue within 3 weeks, which plays a role in strengthening the anastomotic opening, and 2 to 3 months after the insertion, the material will be absorbed without any residue.[8] There are few comparative studies on the placement of PGA materials to prevent PF. In this article, the literatures about PGA materials which was used to strengthen or cover the pancreatic stump after a partial pancreatectomy were systematically retrieved, and whether the physiological effect of PGA materials could reduce POPF was evaluated by meta-analysis.

Our meta-analysis showed the 3 results. First, in general, the risk of total PF and clinical PF (grade B/C) in the PGA group was lower than that in the control group, and the risk of clinical PF was significantly lower than that of overall PF (grade A/B/C) (decreased by 59%, 95% CI 48%–68% vs 24%, 95% CI: 11%–36%, respectively), and there was no significant difference between PGA group and the control group in the incidence of biochemical PF (RR = 1.20, 95% CI: 0.94–1.54). Second, after PD, the risk of overall PF and clinical PF in the PGA group was lower than that in the control group, the risk of clinical PF was significantly lower than that in the total (decreased by 50%, 95% CI: 32%–63% vs 24%, 95% CI 8%–38%, respectively), and there was no significant difference between PGA group and the control group in the incidence of biochemical PF (1.06, 95% CI 0.65–1.72). Third, after DP, the risk of overall PF and clinical PF in the PGA group was lower than that in the control group, and the risk of clinical PF was significantly lower than that in the total PF (decreased by 69%, 95% CI 54%–79% vs 26%, 95% CI 4%–43%, respectively); however, the risk of biochemical PF in the PGA group was significantly higher than that in the control group (RR_{DP} = 134%, 95% CI 104%–174%).

Furthermore, the data stratification was evaluated by the study design (randomized control or retrospective) for DP. It was found that there was no significant difference between the randomized control group and the retrospective cohort group in the occurrence of a PF. In conclusion, PGA materials can prevent the occurrence of PF, which reduced about 24% of the time without PGA mesh, especially for clinical PF, which was 59% (50% in PD and 69% in DP).

PGA mesh can prevent the development of PF. For biochemical PF, most of the results showed that the use of PGA mesh cannot increase the occurrence rate, but the biochemical PF in the control group was higher than that in the PGA group after DP ($P = .03$), which led us to make a bolder conjecture that PGA mesh will make the original clinical PF remain biochemical PF, which will increase the occurrence of biochemical PF. The physiological process may be closely related to the occurrence of inflammation. It has been reported that after intraperitoneal injection of a degraded PGA patch in mice, it can induce acute peritonitis infiltrated by neutrophils, cause repeated inflammation of surrounding tissues and adhesion, thus preventing the occurrence of POPF.[25] The efficacy of PGA mesh, especially the prevention of PF, seems to have been verified by this meta. But more high-quality and multicenter RCTs are still needed. At present, there is 1 such study in progress, the PLANET-PJ trial.[5]

The results of our meta-analysis showed that the PGA group was significantly lower than the control group in estimated blood loss, but there were no significant difference in the operation time and hospital stay. The placement of the PGA mesh and the enhancement of the pancreatic incision will not take a lot of time or bring adverse factors for increased incision bleeding.

As an external preparation, PGA mesh is very simple, safe, and applicable. In addition to being directly placed on the pancreatic stump incision, it can also be installed in the gun ordering system, which only takes a little time, and does not require sophisticated technology. Whether the pancreatic tissue is soft or hard can enhance the closure of the stump. More importantly, this method can be easily applied to laparoscopic surgery without changing the surgical strategy, and it is expected to improve the results of minimally invasive DP.

However, PGA mesh material also has some concerns about whether it will promote infection or delay the healing of PF. Some animal models showed that the use of a PGA mesh capsule increased the susceptibility of infection after splenectomy.[26] Although the meta results show that the POPF rate and the clinic POPF rate are relatively low, it is still worth thinking about whether a PGA patch itself can be used as the source of foreign body infection, and whether there are other similar and better alternative products, but these alternatives will need a lot of basic research and exploration to demonstrate their effectiveness. In the future, in addition to further verifying the role of PGA, we

Table 3

The basic characteristics of the documents before 2010.

	PGA			Control			
Study	**Event**	**Total**	**Leak (%)**	**Event**	**Total**	**Leak (%)**	***P***
Yamamota 2009[27]	2	47	4	5	25	20	<.05
Johnston 2009[28]	16	70	23	7	44	16	>.05
Ferrone 2008[29]	15	45	33	10	41	24	>.05
Guzman 2009[30]	11	15	73	3	15	20	<.05
Thaker 2007[31]	1	29	3	4	11	36	<.05

PGA = polyglycolic acid.

should also explore the development of a PGA mesh specifically suitable for pancreatic surgery.

There were several studies in the PGA group and the control group before 2010. The sample size was small and the PF was not classified, so it was not included in this meta-analysis. The basic characteristics of PF are shown in Table 3. The rate of PF in the incision group with PGA materials fluctuated from 7% to 73%, which is closely related to the research. The rate of PF in the control group without PGA mesh was relatively constant from 16% to 36%.

5. Conclusions

After a partial pancreatectomy, PGA mesh might have the potential to prevent the occurrence and development of PF, reduce POPF, clinical PF and complications. These conclusions still need to be verified by more prospective, multicenter, large sample, and high-quality RCTs.

6. Limitations

There are several limitations in this article. First, due to the lack of a consistent definition of a fistula in some studies of PF, we could not accurately obtain the proportion of PF at all levels, which may have led to the deviation of the meta-analysis results. Secondly, another limitation was that most of the studies included were RCSs, which are particularly prone to selection bias and inconsistent data reporting. Finally, we did not distinguish the proportion of PGA material of the mesh as well as the placement position and method, but regarded the patch containing the PGA component or mesh using PGA as part of the PGA group. Although some studies' settings are well performed, their high level of mixed bias may affect the applicability of this review.

Author contributions

Wei Zhang was responsible for drafting the manuscript, as well as the acquisition, analysis and interpretation of data; Zhicheng Wei contributed to the conception of the study; Xu Che contributed to the conception and design of the current study. All authors read and approved the final manuscript.

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Supplemental file 3, http://links.lww.com/MD/E622

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