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Reconstruction methods and postoperative outcome after proximal gastrectomy for gastric cancer in the upper third of the stomach: A systematic review and meta-analysis

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Abstract

Aim: To systematically review the literature and analyze postoperative outcomes of various reconstructive techniques after proximal gastrectomy.

Method: PubMed, Google scholar and Medline were searched for studies and relevant literature published between 1966 and 2017 regarding various reconstructive methods performed during proximal gastrectomy. The postoperative outcomes of the reconstructive techniques were successfully assessed. Meta-analyses were performed by RevMan 5.0.

Results: In total, 23 studies were included. The studies investigated postoperative outcomes of double tract reconstruction, double flap reconstruction, jejunal pouch interposition, jejunal interposition, gastric tube, esophagogastrostomy and side to side anastomosis. Pooled incidences of reflux esophagitis for these procedures were, 8.2%,8.9%,13.8%,7.4%,13.2%,12.3% and 12.5% respectively.

The five studies were randomized with n=269 participant comparing the postoperative outcomes between JI, JPI and EG were deemed eligible for pooled analyses. Meta-analysis showed no significant difference of reflux esophagitis [Heterogeneity: $Chi^2 = 0.09$, df = 1 (P = 0.76); $I^2 = 0\%$],test for overall effect: Z = 0.24 (P = 0.81).Anastomotic leakage [Heterogeneity: $Chi^2 = 5.20$, df = 2 (P = 0.07); $I^2 = 62\%$],test for overall effect: Z = 0.24 (P = 0.81).Wound infection [Heterogeneity: $Chi^2 = 0.93$, df = 1 (P = 0.34); $I^2 = 0\%$], test for overall effect: Z = 0.42 (P = 0.68). However, analysis of the anastomotic stricture favored the EG group and there was a statistical difference between the two groups [Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 0.05$, df = 1 (P = 0.83); $I^2 = 0\%$], test for overall effect: Z = 2.27 (P = 0.02).

Conclusion: The incidence of reflux esophagitis and anastomotic complications associated with PG was not different among the various reconstructive methods currently under study, but reflux esophagitis and anastomotic stricture were relatively common. PG following jejunal pouch interposition, esophagogastrostomy, side to side anastomosis showed higher incidence of reflux esophagitis. Jejunal interposition and jejunal pouch interposition also showed higher incidence of anastomotic stricture. However optimal reconstruction method is still under study in other to decrease the incidence of postoperative outcome.

Keywords: proximal gastrectomy, double tract reconstruction, double flap reconstruction, jejunal pouch interposition, jejunal interposition, esophagogastrostomy, gastric tube reconstruction, gastric cancer or neoplasms

Introduction

Amazing as it is, gastric cancer rates have dwindled in diagnosis across a large part the world but, lamentably still remains a familiar virulence [1, 2], it still remains the fourth and the second most common malignancy worldwide [3]. The incidence of upper-third gastric cancer, including early gastric cancers, is increasing in Korea, China and Japan [4, 6]. And the cancer-related death rate for proximal gastric cancer (PGC) is higher than what's observed for cancers at other sites of the stomach [7, 9]. A few decades later and many methods tested, the only therapeutic agent deemed reliable as a medicinal procedure of gastric cancer remains only to be surgical resection, even though there is not a general agreement on preference of procedures as a remedy for PGC [10]. Nevertheless, there is still no consensus on the choice of surgical procedures for PGC.

Two distinct stomach resections by surgical procedure for proximity gastric cancer include, total gastrectomy (TG) and proximal gastrectomy (PG). The type of gastrectomy that is chosen of the two by GI surgeons usually rely upon the tumor's size, stage and volume of the remnant in the stomach [11]. Accordingly, various types of reconstructions have been investigated. Japanese gastric cancer treatment guidelines propose 3 types of reconstructions for proximal gastrectomy: esophagogastrostomy, jejunal interposition, double tract jejunal interposition [12]. In addition, jejunal pouch interposition and gastric tube stomach esophagogastrostomy are still perceived as dependable methods [13].

Although total gastrectomy may grant more extended lymph node (LN) dissection, proximal gastrectomy has been found to be effective in being able to provide comparable recurrence and survival rates without compromising the physiological functions of the gastric remnant [7]. Actually, it has been expressed by several authors that proximal gastrectomy is the best appropriate surgical operation of early cancer occurring in upper part of stomach, since it has the best curability and safety for patients that undergo it. Their findings have concluded the evidence that, as stated prior before, proximal gastrectomy has the same survival rates of patients who received the procedure compared to those who receive a total

gastrectomy, while maintaining the physiologic functions of gastric remnant [14]. Nonetheless, proximal gastrectomy may have its pros but, some drawbacks as well. There is a high primary concern of its possible post-operative complications which consist of reflux esophagitis, which causes excessive heartburn, chest pain, regurgitation of sourness, and anorexia, all of which one can agree diminishes the postoperative quality of life of patients [15].

It should be noted that multiple methods are possible for reconstruction after a proximal gastrectomy. Although other reconstruction procedures that are additional such as jejunal interposition (JI) [14], jejunal pouch interposition (JPI) [16] and the double- tract (DT) method [17], in which some distance is maintained between the esophagus and gastric remnant, are efficient in preventing reflux to some extent but, the downside is that these procedures sometimes cause other symptoms that are uncommon with EG, such as obstruction of the passage and difficulty in endoscopic surveillance of the gastric remnant after surgery [18]. Alternatively, due to the high presence of reflux esophagitis after simple esophagogastrostomy, it has inspired advancement of new techniques for reconstruction that purposefully aids to prevent reflux, two of which incorporate jejunal pouch interposition and jejunal interposition [14, 19].

The most common type of reconstruction is esophagogastrostomy. A questionnaire was done at 145 Japanese institutions and it indicated that esophagogastrostomy is desired after a proximal gastrectomy by approximately 50% of institutions [15].

The purpose of this study was to disclose the postoperative effects of different reconstruction techniques succeeding a proximal gastrectomy.

Materials and Method

A literature search was performed in PubMed and Google scholar using the search terms Double Tract Reconstruction or side to side or overlap or Jejunal Interposition or Double Flap or Gastric Tube or Esophagogastrostomy or jejunal pouch interposition and Gastric Neoplasm or Cancer and Proximal Gastrectomy. All titles and abstract of publications were screened to select articles describing various reconstructive technique of proximal gastrectomy for gastric cancer located in the upper third of the stomach. Full text articles of preliminary included studies were screened.

Data extraction

General characteristic of included studies, such as the country, study design, type of reconstruction, time interval and number of patients. The reconstruction types were classified into 7 groups: double tract reconstruction, double flap reconstruction, jejunal pouch interposition, jejunal interposition, esophagogastrostomy side-side anastomosis and gastric tube reconstruction. Incidence of Postoperative outcomes like anastomotic strictures, anastomotic leakage, wound infection, residual food and reflux esophagitis were confirmed by endoscopic examination. Reflux esophagitis was classified by the Los Angeles classification; degree B or more severe degrees were considered are extracted. In studies reporting incidences of reflux esophagitis during various periods, incidences during the 12th month were considered.

In studies separately reporting each postoperative complication, the most frequently observed complication was considered. All analysis was based on previous published studies, meaning no ethical approval and patient consent are required.

Inclusion Criteria

- Only full published paper in English or translated paper.
- Comparative and non-comparative studies included.
- Open or laparoscopic procedure of proximal gastrectomy.

Exclusion Criteria

- Animals or lab studies excluded
- Case reports, comments, letters and reviews without original date excluded.
- postoperative outcomes are not recorded
- Total gastrectomy, subtotal gastrectomy and distal gastrectomy are excluded.

Statistical Analysis

Statistical analysis was performed using the Review Manager (RevMan) software, version 5.0 offered by the Cochrane collaboration. Comparison of dichotomous measures (e.g. Reflux esophagitis, Anastomotic leakage, Anastomotic stricture and Wound infection). A pooled estimate odd ratio (OR), as well as 95% confidence intervals (Cis) was used to assess the dichotomous. Random effect and fixed effect models were computed under statistical methods of mantel-Haenszel (for OR or RR). Heterogeneity among studies was assessed using the inconsistency statistic(I). If I was <50%, the eligible studies were considered to be homogenous; hence, the fixed effect model was used. In contrast if I was >50%, the pooled results were said to be significantly heterogenous, and the random effect model was used instead.

Results

General characteristic of the analyzed patients

A total of 866 studies were searched. Of these searched studies,606 remaining after duplicates removed,606 articles were screened and resulted 517 irrelevant, 22 report,17 meta-analysis,15 review and comment and 5 animal study. Full text articles of the 30 studies were carefully studied and 7 studies lacking targeted data. The remaining 23 studies were included. Of the 23 studies, 23 was analyzed as quantitative studies and 5 out of the 23 is for qualitative studies. The quantitative was in included 23 studies comprising of several reconstructive technique. There studies were 2 papers from china, Zhao et al. [20] and Zhang et al. [21], 19 papers from Japan, senmaru et al. [22], kameyama et al. [19], isobe et al. [23],kazuhiro et al.[24],adachi et al. [25],koruda et al. [26], kondoh et al. [27],yasuda et al. [28], matsui et al. [29], mochiki et al. [30], kano et al. [31], ahn et al. [32], ueda et al. [33], kamitaka et al. [34], nomura et al. [35], sugiyama et al. [36], omori et al.[37], Saeki et al. [38] and Uyama et al. [39], 1 paper from Korea, kim et al.[40] and 1 paper from Scotland, wright et al. [41]. 5 were randomized control trial with n=274 participant, 17 were retrospective studies with n=399 participant and 1prospective study with n=30 participant. There were JI group with n=169 participants, JPI group with n=83 participants, EG group with n=174 participants, GTR group with n=68 participants, DFR group with n= 560 participants group with, S-SA group with n=8 participants. Studies reported postoperative outcomes such as reflux esophagitis, anastomotic leakage, anastomotic stricture, residual food and wound infection.

The qualitative studies included 5 studies comparing JI VS JPI and JI VS EG after proximal gastrectomy. All the studies included are from japan: Yasuda et al.. [28], kameyama et al.

[19], isobe et al. [23] and Kazuhiro et al. [24] and Senmaru et al. [22]. The five studies were randomized with n=269 participant. The total participant undergoing JI group were n=83 participants JPI group were n= 83 participants and EG group were n=102 participants. The mean age of participant was 60.08 in JI, 57.0 in JPI and 70.83 in EG respectively with a total number of 200 males and 69 females.

Reflux esophagitis

Two papers [19, 23] were used for the analysis with JI (n=33) patients and JPI (n=58) patients with the total participant n=91.Two studies was homogenous, hence fixed effect was used [Heterogeneity: $Chi^2 = 0.09$, df = 1 (P = 0.76); I^2 = 0%].There was no statistical significance difference between the two type of reconstructive technique. Test for overall effect: Z = 0.09 (P = 0.93). fig2

Anastomotic Leakage

Two papers [19, 22] were used for the analysis of JI (n= 22) patients and JPI (n=58) patients with total participant n=80. Two studies were homogenous, hence fixed effect was used[Heterogeneity: $Chi^2 = 0.47$, df = 1 (P = 0.49); I^2 = 0%].There was no statistical significance difference between the two methods of reconstruction. Test for overall effect: Z = 0.24 (P = 0.81). fig3

Reflux esophagitis

Two papers [23, 24] were used for the analysis with JI (n= 37) patients and EG (n=76) patients with the total participant of 113.Two studies were heterogenous, hence random effect was used [Heterogeneity: Tau^2 =2.02 $Chi^2 = 2.38$, df = 1 (P = 0.12); I^2 = 58%].The was no statistical significance difference between the two types of reconstructive method. Test for overall effect: Z = 1.05 (P = 0.29). fig 4

Anastomotic leakage

Three papers [23, 24, 28] were used for the analysis with JI (n=58) patients and EG 102with total participant of 160.The three studies were heterogenous, hence random effect was used[Heterogeneity: $Chi^2 = 5.20$, df = 2 (P = 0.07); I^2 = 62%]. The was no statistical significance difference between the three procedures. Test for overall effect: Z = 1.16 (P = 0.24). fig 5

Anastomotic stricture

Two studies [23, 28] were used for the analysis with JI (n=44) patient and EG (n=91) with total participant of 135. The two studies were homogenous, hence fixed effect was used[Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 0.05$, df = 1 (P = 0.83); I^2 = 0%]. There was a statistical significance difference between the two studies. Test for overall effect: Z = 2.27 (P = 0.02). fig 6

Wound infection

Two studies [24, 28] were used for the analysis with JI (n=35) patients and EG (n=36) with total participant of 71.The two studies were homogenous, hence fixed effect was used[Heterogeneity: $Chi^2 = 0.93$, df = 1 (P = 0.34); I^2 = 0%]. The was no statistical difference between the two reconstructive methods. Test for overall effect: Z = 0.42 (P = 0.68). fig 7

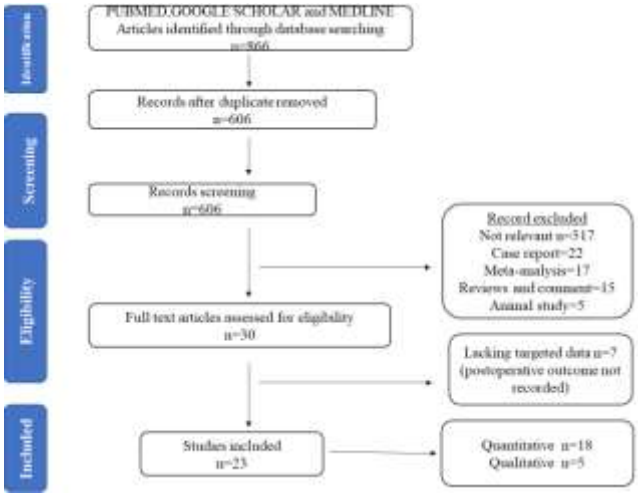

Fig 1

Characteristics of included studies

The characteristics of the 22 studies are listed in table below. The published year ranged from 1966 to 2017. 21 retrospective studies, 1prospective studies and 12 comparative and 10 case series. The reconstruction types were classified into 6 groups: double tract reconstruction, double flap reconstruction, jejunal pouch interposition, jejunal interposition, esophagogastrostomy and gastric tube reconstruction.

Table 1: Qualitative studies

Reference	Country	Study interval	Design	Groups	No. patient
wright et al. [41]	Scotland	1966-1985	RS	JI	30
Kameyama et al. [19]	Japan	1985-2002	RC	JI/JPI	13/59
Senmaru et al. [22]	Japan	1996-1998	RC	JI/JPI	12/12
Isobe et al. [23]	Japan	1989-2008	RC	EG/JI/JPI	66/23/12
kazuhiro et al. [24]	Japan	1992-1996	RC	EG/JI	11/14
Adachi et al. [25]	Japan	1992-1998	RC	JI/GTR	16/14
Kuroda et al. [26]	Japan	1996-2015	RS	DFR	464
kondoh et al. [27]	Japan	1997-2004	RS	EG	10
Yasuda et al. [28]	Japan	2001-2005	RC	EG/JI	25/21
Matsui et al. [29]	Japan	2003-2006	RS	S-SA	6
Mochiki et al. [30]	Japan	2006-2011	RS	GTR	41
Kano et al. [31]	Japan	2006-2015	RS	DFR	51
zhao et al. [20]	China	2009-2011	RS	JI	35
Ahn et al. [32]	Japan	2009-2012	RS	DTR	43
Ueda et al. [33]	Japan	2009-2014	RS	GTR	13
Kim et al. [40]	Korea	2009-2014	RS	DTR	27
Zhang et al. [21]	China	2011-2013	RS	EG	62

Kamitaka et al. [34]	Japan	2011-2016	RS	DTR	10
Nomura et al. [17]	Japan	2012-2016	PS	DTR/JI	15/15
Sugiyama et al. [36]	Japan	2013-2016	RS	DTR	10
Omori et al. [37]	Japan	2014-2017	RS	DFR	32
Saeki et al. [38]	Japan	2015-2016	RS	DFR	13
Uyama et al. [39]	Japan	-	RS	S-SA	2

Table 2: Quantitative studies

Reference	Country	Study interval	Design	Groups	No. patient	Age	Gender ratio men to women
Senmaru et al. [22]	Japan	1996-1998	RC	JI/JPI	12/12	62.3 ± 3.4(JI)/ 52.1 ± 2.1(JPI)	8:4/7:5
Kameyama et al. [19]	Japan	1985-2002	RC	JI/JPI	13/59	59.3(JI)/59.0(JPI)	44:15/11:2
Isobe et al. [23]	Japan	1989-2008	RC	EG/JI/JPI	66/23/12	71.6±9.6(EG)/59.4±8.5(JI)/59.9±9.8(JPI)	54:14/18:5/9:2
Kazuhiro et al. [24]	Japan	1992-1996	RC	EG/JI	11/14	69.3 ±2.4(JI)/58.4 ±2.4(JPI)	10:1/8:6
Yasuda et al. [28]	Japan	2001-2005	RC	EG/JI	25/21	71.6 ± 8.6(JI)/61.0 ± 9.5(JPI)	18:7/13:8

Table 3: Postoperative outcomes

Authors	Reflux esophagitis	Anastomotic stricture	Anastomotic leakage	Residual food
Double tract				
Ahn et al. [32]	2/43(4.65%)	2/43(4.65%)	-	21/43(48.9%)
kim et al. [40]	2/17(11.8%)	0/17(0%)	1/17(5.9%)	-
kamitaka et al. [34]	2/10(20%)	-	0/10(0%)	-
nomura et al. [17]	1/15(6.7%)	1/15(3.3%)	0/15(0%)	2/15(13.3%)
Sugiyama et al. [36]	-	0/10(0%)	1/10(10%)	-
Total	7/85(8.2%)	3/85(3.5%)	2/52(3.9%)	23/58(39.6%)
Double flap reconstruction				
Kano et al. [31]	3/51(5.9%)	4/51(8%)	0/51(0%)	2/51(3.9%)
Koruda et al. [26]	46/464(10.6%)	26/464(5.5%)	7/464(1.5%)	-
Omori et al. [37]	0/32(0%)	0/32(0%)	0/32(0%)	-
Saeki et al. [38]	1/13(7.7%)	-	1/13(7.7%)	-
Total	50/560(8.9%)	30/547(5.5%)	8/560(1.4%)	2/51(3.9%)
Jejunal pouch interposition				
Senmaru et al. [22]	-	1/12(8.3%)	0(0%)	-
Kameyama et al. [19] Isobe et al. [23]	6/46(13.0%) 2/12(16.7)	- 1/12(8.3%)	9/46(15.3%) 1/12(8.3%)	23/46(50.0%) -
Total	8/58(13.8%)	1/12(16.7%)	10/58(17.2%)	23/46(50.0%)
Jejunal interposition				
wright et al. [41]	2/30(6.7%)	1/30(3.3%)	3/30(10%)	8/30(26.7%)
Senmaru et al. [22]	-	2/12(16.7%)	1(8.3%)	-
kameyama et al. [19]	3/10(30.0%)	-	0/10(0.0%)	3/10(30.0%)
isobe et al. [23]	3/23(13.0)	0/23(0%)	3/23(13.0)	-
kazuhiro et al. [24]	0/14(0%)	9/14(64.3%)	0/14(0%)	-
adachi et al. [25]	0/16(0%)	1/16(6.3%)	0/16(0%)	-
yasuda et al. [28]	1/23(5%)	3/21(14.3%)	2/21(10%)	17/17(100%)
zhao et al. [20]	2/31(6.5%)	-	0/35(0%)	-
Nomura et al. [17]	1/15(6.7%)	1/15(3.3%)	0/15(0%)	4/15(26.7%)
Total	12/162(7.4%)	15/119(13.0%)	9/176(5.1%)	15/72(20.3%)
Gastric tube				
Adachi et al. [25]	1/14(7.1%)	1/14(7.1%)	0/14(0%)	-
Mochiki et al. [30]	5/41(12.5%)	6/41(14.6%)	2/41(4.8%)	-
ueda et al. [33]	3/13(23.1%)	0/13(0%)	0/13(0%)	-
Total	9/68(13.2%)	7/68(10.3%)	2/68(2.9%)	
Esophagogastrostomy				
isobe et al. [23]	12/66(18.2%)	2/66(3.0%)	1/66(1.5%)	-
kazuhiro et al. [24]	4/10(40%)	2/10(20%)	2/11(18.2%)	-
kondoh et al. [27]	4/10(40%)	4/10(40%)	0/10(0%)	-
yasuda et al. [28]	1/23(4.3%)	0/25(0%)	0/25(0%)	-
zhang et al. [21]	9/62(14.5%)	11/62(7.1%)	5/62(8.1%)	-
Total	21/171(12.3%)	19/173(1.0%)	8/174(4.6%)	
Side-side Anastomosis				
matsui et al. [29]	1/6(16.7%)	-	0/6(0%)	0/6(0%)
uyama et al. [39]	0/2(0%)	0/2(0%)	-	-
Total	1/8(12.5%)	0/2(0%)	0/6(0%)	0/6(0%)

Double tract reconstruction

Five studies reported double tract reconstruction and a total 105 patients were involved. Postoperative outcomes like Reflux esophagitis, Anastomotic stricture, Anastomotic

leakage and Residual food were observed in 8.2%,3.5%,3.9% and 39.6% respectively. Reflux esophagitis and residual food were the most frequently observed.

Double flap reconstruction

Four studies reported double flap reconstruction and a total 560 patients were involved. Postoperative result like Reflux esophagitis, Anastomotic stricture, Anastomotic leakage and Residual food were observe in 8.9%,5.5%,1.4% and 3.9%. Reflux esophagitis and Anastomotic stricture were the most frequently observed.

Side to side Anastomosis

Two studies focused on the outcomes of side to side anastomosis and 8 patients were involved. only Reflux esophagitis was observed in 12.5%. There were no outcomes of anastomotic stricture, anastomotic leakage and residual food observed in the patient.

Jejunal pouch interposition

A total of 2 studies concentrated on the postoperative condition of patients who underwent a Jejunal pouch interposition and a total 71 patients were involved. Incidences of patients who developed postoperative outcomes, Reflux esophagitis, Anastomotic stricture, Anastomotic leakage and Residual food was13.8%,16.7%,17.2% and 50.0% respectively. Residual food and anastomotic leakage were the most observed. The incidence of residual food was reported to be high.

Jejunal interposition

A total of 8 studies reported postoperative conditions of the jejunal interposition and 167 patients were involved. Incidence of postoperative outcomes were 7.4%,13.0%,5.1% and 20.3% for Reflux esophagitis, Anastomotic stricture, Anastomotic leakage and Residual food respectively. Reflux esophagitis and Residual food were the most observed. Residual food had the high incidence.

Esophagogastrostomy

A total of 5 studies referred esophagogastrostomy. Of these patients, outcomes like, Reflux esophagitis, Anastomotic stricture and Anastomotic leakage were observed in 12.3%,1.0% and 4.6% of cases, respectively. Reflux esophagitis and anastomotic leakage were the most frequently observed postoperative outcomes.

Gastric tube reconstruction

Three studies reported Gastric tube reconstruction and a total of 68 patients were involved. Reflux esophagitis, Anastomotic stricture and Anastomotic leakage were observed in 13.2%, 10.3% and 2.9% respectively. Making reflux esophagitis with the high incidence. The incidence of residual food was not reported by any of the studies. Although not emphasized by the included studies, reflux esophagitis seemed to be the major concern.

Comparison of JI vs JPI AND JI vs EG

A total of 5 studies compared the postoperative outcomes of the reconstruction technique: 3 studies compared jejunal interposition versus esophagogastrostomy [23, 24, 28], 3 studies compared jejunal interposition versus jejunal pouch interposition [19, 22, 23]. Study comparisons are shown in below;

Of the 3 studies comparing outcomes of Jejunal interposition and Jejunal pouch interposition,1 study observed high risk of reflux esophagitis (30.0% vs 13.0%), and 1 study found decrease risk of reflux esophagitis (13.0% vs 16.7%). Only 1 study recorded high risk of anastomotic stricture (16.7%/13.0%). Another 1 study recorded high incidence of residual food (30.0% vs 50.0%). Another study of Anastomotic leakage (0% vs 15.3%).

Of the 3 studies comparing jejunal interposition and esophagogastrostomy,1 study shows high risk of reflux esophagitis (13.0% vs 18.2%) and 1 studies observed decrease risk of reflux esophagitis(0% vs 40.0%).For anastomotic stricture,1 study shows high risk of 14.3% vs 0% and another shows decrease risk of 0% vs 3.0%.1 study show high risk of 13.0% vs 1.5% and decrease risk of 10% vs 0% for anastomotic leakage.1 study shows high risk of 14.3% vs 0% for wound infection and decrease risk of 9.5% vs 12.0 % for wound infection. No study recorded residual food.

Table 4: Comparison of JI VS JPI and JI S EG

Reference	Reflux Esophagitis	Anastomotic stricture	Anastomotic leakage	Wound infection	Residual food
JI/JPI					
Senmaru et al. [22]	-	16.7%/8.3%	8.3%/0%	8.3%/0%	-
Kameyama et al. [19]	30.0%/13.0%	-/-	0% /15.3%	-/-	30.0%/50.0%
Isobe et al. [23]	13.0%/16.7%	-/8.3%	-/8.3%	-/-	-/-
JI/EG					
Isobe et al. [23]	13.0%/18.2%	0/3.0%	13.0%/1.5%	-/-	-/-
Kazuhiro et al. [24]	0%/40%	-/-	0%/18.2%	14.3%/0%	-/-
Yasuda et al. [28]	5%/4.3%	14.3%/0%	10%/0%	9.5%/12.0%	-

Meta-analysis Result

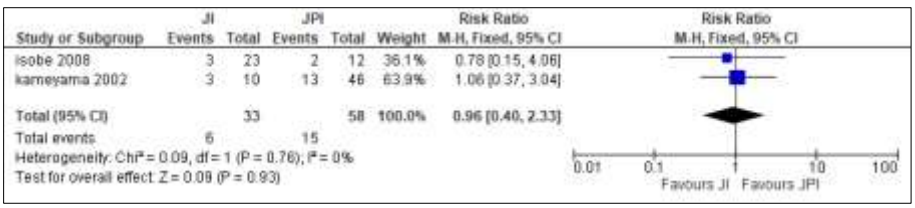

Fig 2

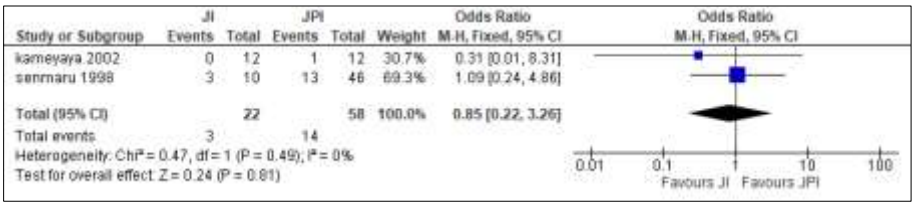

Fig 3

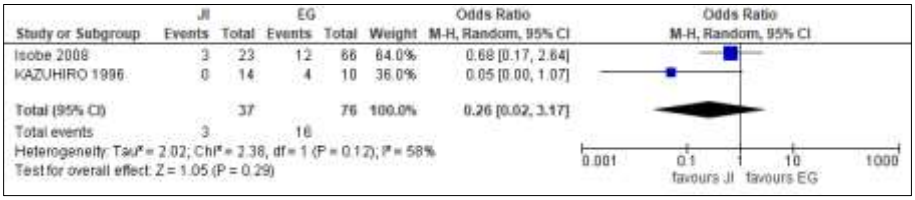

Fig 4

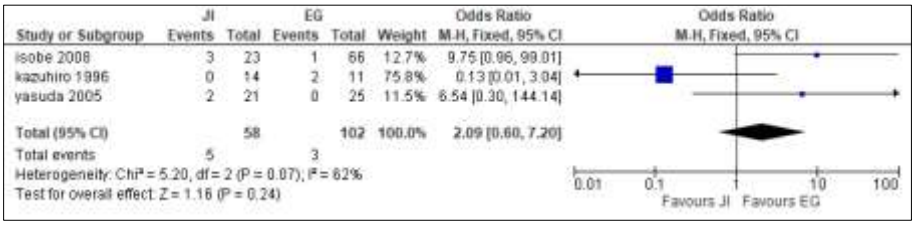

Fig 5

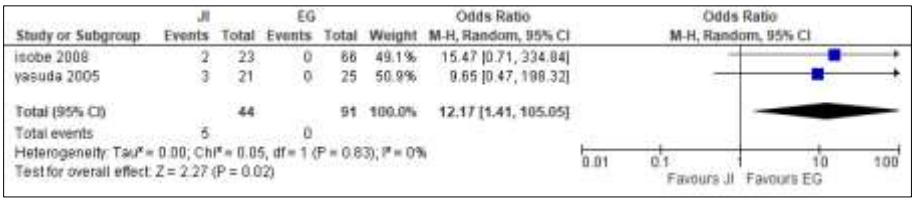

Fig 6

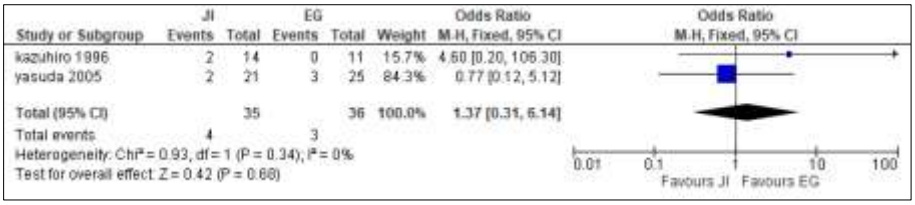

Fig 7

Publication Bias

Of the five studies, three papers were used to determine the bias and other two studies were lacking insufficient data. The funnel plot based on the outcomes are shown in fig 8. Because all studies laid inside the 95% CI limits, no evidence of publication bias was noted. Egger test was performed to provide statistical evidence regarding funnel plot symmetry. Result still did not reveal any evidence of publication bias in age (Heterogeneity: $Chi^2 = 0.35$, df = 2 (P = 0.84); $I^2 = 0\%$)

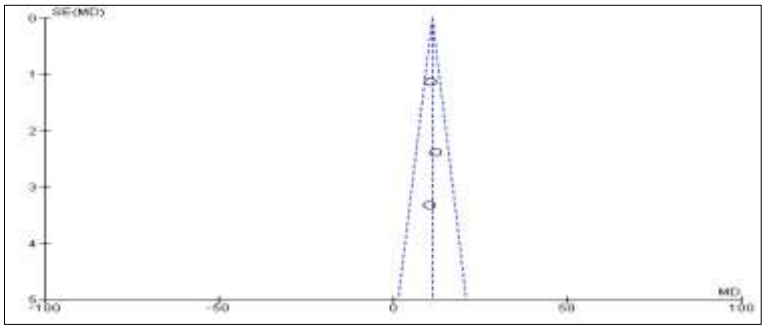

Fig 8

Discussion

The standard surgery preferred for advanced proximal gastric cancer has always favored total gastrectomy. Whereas, for early stage proximal gastric cancer, proximal gastrectomy has been the typical surgical solution [25, 42, 46]. The study reviewed and analyze the postoperative outcomes among 23 studies and some of the studies also underwent a meta-analysis. Proximal gastrectomy is a considerable resection procedure for early stage of proximal gastric cancer providing that a sufficient distal resection margin can be ensured. This has been generally accepted by most GI surgeons [47]. However, in the cases of advanced diseases, it still has not reached a general consensus for its preference. Moreover, if the rate of reflux esophagitis and anastomotic structure after proximal gastrectomy can be reduced to that of total gastrectomy, proximal gastrectomy may become an advantageous treatment of choice for proximal EGC [32].

The review and meta-analysis that was completed were based on seven reconstructive techniques, six of which consisted of anti-reflux techniques. The totality of the anti-reflux reconstruction methods tested demonstrated an excellent ability in preventing reflux. The postoperative effects that were under observance included reflux esophagitis, anastomotic stricture, anastomotic leakage, residual food and wound infection. Additionally, it was found that the preventive reflux methods within several studies, increased the incidence of residual food, reflux esophagitis, anastomotic stricture and anastomotic leakage in all studies. Double tract, double flap method and jejunal interposition, which are also conducted after proximal gastrectomy as well as the combined incidence of reflux esophagitis was 8.2%,8.9% and 7.4% which seemed to be proven effective to lower the outcome of reflux compared to the procedures of jejunal pouch, gastric tube, side to side anastomosis and the esophagogastrostomy. But, despite the excellent anti-reflux results, the three studies of the interposed jejunum between the remnant stomach and esophagus presented other complications. Because of the increased anastomosis numbers and technique complexity, postoperative complications, such as anastomotic leakage, anastomosis stricture and residual food were shown to increase accordingly. Anastomotic Stricture (64.3%) were frequently seen in jejunal interposition [24], anastomotic leakage (18.2%) observed in esophagogastrostomy [24] and residual food (100%) were frequently observed in the jejunal interposition group [28] which were in higher incidence. Three studies also reported stronger anti-reflux efficacy [25, 37, 39], whereas others showed negative result.

With the development of clinical research, proximal gastrectomy has been gradually replacing the practice of total gastrectomy in treating early gastric cancer located in the upper third of the stomach. Proximal gastrectomy has maintained comparable oncological radicality to the total gastrectomy and the reservoir capacity of the stomach [8, 16], pT1-2 gastric cancer located in the upper third of the stomach has rarely shown any pathological lymph node metastasis at stations #4d, #5, and #6..Although no difference in the long-term survival has been detected between the total and the proximal gastrectomy [48], cardio-esophageal resection and the reserved stomach were shown to significantly increase the risk of gastroesophageal reflux and significantly decrease the postoperative quality of life [16].

PG has a high risk of postoperative gastroesophageal reflux and food stagnation, both of which remarkedly decreases the quality of life of patients. Laparoscopic surgery has emerged as an option for the surgical treatment of EGC, including PG. Laparoscopic reconstruction and the improvements of reconstruction methods in PG in order to prevent regurgitation of gastric contents and to facilitate their discharge into the duodenum are important issues [28]. With regard to EG reconstruction, Adachi et al. [25] and Shiraishi et al. [49] performed EG with a narrow gastric tube and reported it to be a safe and simple procedure with benefits such as a shorter operation time, faster recovery, and lower hospital expenses compared with JI and an equally low incidence of reflux esophagitis despite an end to-end anastomosis. However, regurgitation when lying down cannot be avoided. Meanwhile, Ichikawa et al. [50] reported that EG was performed in an end-to-side fashion using a narrow gastric tube laparoscopically, resulting in favorable clinical outcomes, along with a low incidence of reflux esophagitis and preservation of the physiological function of the remnant stomach. However, the length of the newly created pseudo-fornix was less than 3 cm, which seemed to be inadequate to function as an angle of His for the prevention of reflux. Related research has also confirmed that PGJI improves reflux esophagitis, compared with esophagogastrostomy [14, 51].

Limitations of the techniques were shown to be the incurability of tumors located in the greater curvature and the decreased volume of the stomach, which may alter food intake and nutrition status [25]. So actual treatment efficacy remains to be determined. There are two major limitations in the present study that was recognized. First, most of the studies on the outcomes of reconstructions for proximal gastrectomy were retrospective case series and non-randomized comparative studies. Also, a downside was that comparisons between the reconstructions were unavailable. Second, in the included studies, various types of complications and various diagnostic criteria of postoperative reflux esophagitis were adopted. As a result, postoperative complications, including esophageal reflux, were described in general; each type of complication was not described in detail. Given the preliminary stage of this study on the reconstruction following a proximal gastrectomy, it was difficult to estimate the occurrence of each complication and to summarize the presence of reflux esophagitis by each diagnostic criterion. It is important that we must first investigate general data of the reconstructions.

In summary, anti-reflux reconstruction methods involved in the studies increased the possible rate of surgical complexity, higher incidence of anastomosis stenosis, anastomosis leakage, and residual food. Nevertheless, such methods, excluding esophagogastrostomy, jejunal pouch interposition and side to side anastomosis, effectively did decrease the risk of reflux esophagitis after proximal gastrectomy. Due to the lack of large randomized studies, optimal anti-reflux methods remain to be unidentified.

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