International Journal of Surgery 76 (2020) 101–110

Contents lists available at ScienceDirect

International Journal of Surgery

journal homepage: www.elsevier.com/locate/ijsu

Review

Comparative analysis of weight loss and resolution of comorbidities between laparoscopic sleeve gastrectomy and Roux-en-Y gastric bypass: A systematic review and meta-analysis based on 18 studies

Youkui Han[a,1], Yang Jia[b,1], Honglei Wang[a], Lei Cao[a], Yongjie Zhao[a,*]

[a] Department of General Surgery, Tianjin Union Medical Center, Tianjin, 300121, China
[b] Department of Gerontology, First Teaching Hospital of Tianjin University of Traditional Chinese Medicine, Tianjin, 300193, China

ARTICLE INFO

Keywords:
Bariatric surgery
Laparoscopic Roux-en-Y gastric bypass
Laparoscopic sleeve gastrectomy
Obesity

ABSTRACT

Background: Laparoscopic Roux-en-Y gastric bypass and laparoscopic sleeve gastrectomy are the most common procedures performed in bariatric surgery and both have been demonstrated to have significant effectiveness in treating morbid obesity. However, comparative analysis of their effectiveness has not been well studied. This comparative analysis was conducted to determine whether Laparoscopic Roux-en-Y gastric bypass and laparoscopic sleeve gastrectomy have the same mid- and long-term outcomes in weight loss, resolution of obesity comorbidities and adverse events (AEs) of treatment.

Methods: We searched the Cochrane Library, PubMed, Embase and Web of Science databases from the establishment of the database to January 1, 2020 for both randomized control trials and non-randomised interventional studies that studied Laparoscopic Roux-en-Y gastric bypass and laparoscopic sleeve gastrectomy with respect to weight loss outcomes, resolution of obesity comorbidities and AEs of treatment. Standardised mean differences, risk ratios and odds ratio with 95% confidence intervals were calculated to compare the outcomes of the groups. Two reviewers assessed the quality of the trials and extracted the data independently. All statistical analyses were performed using the standard statistical procedures in Review Manager 5.2.

Results: We included 20 studies (N = 2917 participants) in this meta-analysis. Our results showed no significant difference in excess weight loss between Laparoscopic Roux-en-Y gastric bypass and laparoscopic sleeve gastrectomy, with pooled Standardised mean differences of −0.16 (95% confidence interval: −0.52 to 0.19; $P = 0.36$) based on randomized control trials and 0.07 (95% confidence interval: −0.10 to 0.24; $P = 0.41$) based on non-randomised interventional studies. Further, the pooled results showed no significant differences in midterm and long-term weight loss outcomes between the comparative groups. Similarly, no significant difference was found in type 2 diabetes mellitus resolution. The pooled results indicated that patients receiving laparoscopic sleeve gastrectomy experienced fewer postoperative complication and reoperation rates, with pooled risk ratios of 1.66 (95% confidence interval: 1.33 to 2.07; $P < 0.00001$) and 1.73 (95% confidence interval: 1.14 to 2.62; $P = 0.01$), respectively. Laparoscopic Roux-en-Y gastric bypass was superior to laparoscopic sleeve gastrectomy in managing dyslipidemia, hypertension and gastroesophageal reflux disease.

Conclusions: The present meta-analysis indicated that both Laparoscopic Roux-en-Y gastric bypass and laparoscopic sleeve gastrectomy had the same effectiveness in resulting in excess weight loss and type 2 diabetes mellitus resolution. However, patients who received laparoscopic sleeve gastrectomy experienced fewer postoperative complication and reoperation rates than those who received Laparoscopic Roux-en-Y gastric bypass. Laparoscopic Roux-en-Y gastric bypass was superior in the management of dyslipidemia, hypertension and gastroesophageal reflux disease.

1. Introduction

Between 1980 and 2000, the prevalence of obesity increased significantly among adult men and women in the United States [1,2]. Flegal KM et al. [3] examined obesity prevalence for 2013–2014 and trends over the decade from 2005 through 2014 adjusting for sex, age,

* Corresponding author. Department of General Surgery, Tianjin Union Medical Center, 190 Jieyuan Road, Hongqiao District, Tianjin 300121, China.
E-mail address: yhwang1026@126.com (Y. Zhao).
[1] Youkui Han and Yang Jia contributed equally to this work.

https://doi.org/10.1016/j.ijsu.2020.02.035
Received 27 October 2019; Received in revised form 20 February 2020; Accepted 24 February 2020
Available online 06 March 2020
1743-9191/

race/Hispanic origin, smoking status, and education. Their result, which based on data from 2638 adult men (mean age, 46.8 years) and 2817 women (mean age, 48.4 years) from the most recent 2 years (2013–2014) of NHANES and data from 21,013 participants in previous NHANES surveys from 2005 through 2012, indicated that the age-adjusted prevalence of obesity in 2013–2014 was 35.0% among men and 40.4% among women. For women, the prevalence of overall obesity and of body mass index (BMI) ≥40 obesity showed significant linear trends for increase between 2005 and 2014 [1].

Bariatric surgery has many benefits, including promoting weight loss and the resolution of type 2 diabetes mellitus (T2DM) and other comorbidities of obesity [4,5]. Weight loss is associated with short-term amelioration and prevention of metabolic and cardiovascular disorders, but whether these benefits persist over time is unknown. In addition, Sjöström et al. reported that bariatric surgery appears to be a more viable option for treating severe obesity compared with conventional therapy, being associated with long-term weight loss, improved lifestyle and, except for hypercholesterolemia, amelioration of risk factors present at baseline Furthermore, the 2- and 10-year rates of recovery from diabetes, hypertriglyceridaemia, low levels of high-density lipoprotein cholesterol, hypertension and hyperuricemia were more favourable in the surgery group than in the control group, whereas recovery from hypercholesterolemia did not differ between the groups. Moreover, the surgery group had lower 2- and 10-year incidence rates of diabetes, hypertriglyceridaemia and hyperuricemia than the control group; no differences between the groups in the incidence of hypercholesterolemia and hypertension were detected [4]. Laparoscopic Roux-en-Y gastric bypass and laparoscopic sleeve gastrectomy (LRYGB and LSG) are the most commonly performed procedures in bariatric surgery. However, their weight loss efficacy in the mid- and long-term has not been compared. Thus, this study compared LRYGB and LSG in terms of mid- and long-term weight loss, and the resolution of comorbidities.

Bariatric surgery has been established as a stand alone treatment for morbid obesity, and has been widely adopted [1]. It is the only therapeutic option that results in substantial and long-lasting weight loss [2–4]. Laparoscopic LRYGB and LSG are the two most popular bariatric procedures performed in the United States [5]. However, they have not been sufficiently compared in terms of long-term effectiveness for weight loss and resolution of comorbidities [6].

Documentation of long-term weight loss following bariatric surgery is insufficient, as a substantial proportion of patients are lost to follow-up over the years following enrolment in the weight loss program. Additionally, some patients who have undergone LSG later undergo revisional surgery due to inadequate weight loss or weight regain [7–9]. For this reason, it has not been determined whether LRYGB or LSG is superior for weight loss and resolution of comorbidities.

Though previous analysis have been conducted, there has been no consistency among reports of the efficacy of LRYGB and LSG for weight loss and resolution of comorbidities, such as T2DM, reoperation, obstructive sleep apnea hypopnea syndrome (OSAHS), hypertension, gastroesophageal reflux disease (GERD), back or joint pain and depression. In addition, two updated RCTs [10,11] have been published recently which have not been included in previous analysis. Thus, this comparative analysis was conducted to determine whether LRYGB and LSG are equivalent for mid- and long-term weight loss, resolution of comorbidities and adverse events (AEs) with a large sample size of both randomized control trials (RCTs) and non-randomised studies of interventions (NRSI) studies.

2. Methods and materials

2.1. Criteria for considering studies

2.1.1. Including criteria

The inclusion criteria were as follows: (1) randomised controlled trials (RCTs), prospective or observational retrospective study; (2) patients with body mass index (BMI) ≥ 40 kg/m^2 or ≥ 35 kg/m^2 with one or more comorbid conditions such as T2DM, OSAS, dyslipidemia, hypertension, and back pain/joint pain with arthritis, aged of 18–60 years, and undergoing bariatric surgery for weight loss or comorbidities; (3) patients who underwent primary LRYGB or LSG; (4) report of relevant outcomes, i.e. weight loss and/or comorbidity resolution rate; and (5) study published in English; (5) studies published up to January 1, 2020.

2.1.2. Excluding criteria

The exclusion criteria were as follows: (1) experimental trial on animals or non-human study; (2) abstract, letter, editorial, expert opinion, review, or case report; (3) patients undergoing other bariatric procedures, revision or conversion procedures; (4) other diseases that may influence outcome; (5) insufficient data or not meeting our inclusion criteria; and (6) not published in English.

2.2. Search strategy

We searched the Cochrane Library, PubMed, Embase and Web of Science databases from the establishment of the database to January 1, 2020. Our search terms were: “bariatric surgery”; “sleeve gastrectomy”; “LSG”; “SG”; “gastric bypass”; “RYGB”; “Roux-en-Y gastric bypass”; “LRYGB”; “obesity” and “diabetes”. The reference sections of some studies were also searched. Two assessors independently screened the titles and abstracts of each study. When a relevant study was identified, the full text was obtained for further evaluation.

2.3. Definition of outcomes

(1) Overall outcomes: including both mid and long term outcomes, or the follow-up time was not stated;
(2) Midterm outcomes: events or outcomes happened within 12–36 months;
(3) Long-term outcomes: events or outcomes happened after 36 months.

2.4. Quality assessment

Two assessors, who underwent standardised training prior to this meta-analysis, independently evaluated the quality of all of the included studies using the Jadad score for RCT studies [12] and the 9-star Newcastle-Ottawa Scale for non-RCT studies [13]. In addition, the risk of bias for each RCT or NRSI, and across all RCTs or NRSI, was evaluated, as illustrated by figures generated using RevMan 5.2 software [14].

2.5. Data extraction

Data for the comparative analysis of mid- and long-term weight loss outcomes and resolution of comorbidities, between LRYGB and LSG, were extracted independently by two reviewers; disagreement was resolved by discussion. The data extracted from each study, including year of publication, country of origin, study design, patient demographics such as gender, mean age, and BMI, follow-up time, and main outcomes were collated using a standardised form.

Data were inputted into RevMan 5.2 software for analysis [14].

2.6. Statistical analysis

Outcome data were compared between the LRYGB and LSG groups, combined across studies, using the standard statistical procedures provided in RevMan 5.2 [14]. Standardised mean differences (SMDs), risk ratio (RR) or odds ratio (OR) and its associated 95% confidence interval (CI) were measured. SMD was used for continuous variable, and RR/OR was used for dichotomous. Heterogeneity among studies

was evaluated by the chi-square-based Q statistic test [15]; the $P_{(heterogeneity)}$ (P_h) value and I^2 statistic, ranging from 0% to 100%, were used to quantify the effect of heterogeneity [16]. $P_h \leq 0.10$ was deemed to represent significant heterogeneity, and pooled risk ratios (RRs) were estimated using a random-effect model (DerSimonian and Laird method [17]). When no statistical heterogeneity was observed ($P_h > 0.10$), a fixed effects model (Mantel–Haenszel method [18]) was used. The outcome measures were considered significantly different between the treatment groups if pooled SMDs with 95% CIs did not overlap with 0, or pooled RRs/ORs with 95% CIs did not overlap with 1.

This study strictly abided by the standards of the Preferred Reporting Items for Meta-analysis and Meta-Analyses (PRISMA) [19] and Assessing the Methodological Quality of Systematic Reviews (AMSTAR) guidelines [20].

3. Results

3.1. Included studies, study characteristics, and quality assessment

In total, 2491 studies were initially identified; after duplicates were removed, the titles and abstracts of 1734 studies were screened. Of these, 933 studies were excluded, and the full texts of the remaining 801 studies were obtained for further evaluation. After reading the full texts, 783 studies were excluded for various reasons. Ultimately, 9 RCTs [6,10,11,21–26] and 9 NRSI [27–35] (N = 2917 participants) were included in this meta-analysis (Fig. 1). Among the studies, the sample size ranged from 15 to 1038 patients [24,34]. The follow-up time ranged from one month to 82.2 months [21,24].

Graphs showing risk of bias were then generated. The overall risk of bias for each RCT is presented as a percentage relative to all included studies in SFig. 1, and the risk of individual types of bias is displayed in SFig. 2. The risk of bias graphs for the RCTs indicated generally good methodological quality, mainly in terms of selection and reporting biases. However, there was a high risk of performance bias in all studies. An unclear risk of bias was mainly seen in terms of detection and "other" biases. The overall risk of bias for each NRSI is presented as a percentage relative to all included studies in SFig. 3, and the risk of individual types of bias is displayed in SFig. 4. The risk of bias graphs for the NRSI indicated generally good methodological quality, mainly in terms of selection (except ascertainment of exposure) and comparison bias. However, there was a high risk of ascertainment of exposure. An unclear risk of bias was mainly seen in terms of ascertainment of exposure and other bias.

3.2. Comparison of weight loss between LRYGB and LSG

As shown in Fig. 2, no significant difference in excess weight loss between LRYGB and LSG was found based on RCTs, with a pooled standardised mean difference (SMD) of −0.16 (95% CI: −0.52 to 0.19; $P = 0.36$). The pooled results also showed no significant difference in midterm and long-term weight loss weight loss between LRYGB and LSG, with pooled SMDs of −0.19 (95% CI: −2.17 to 1.80; $P = 0.85$) and 0.15 (95% CI: −0.59 to 0.89; $P = 0.70$). In addition, as shown in Fig. 3, based on data from NRSI, no significant difference in excess weight loss between LRYGB and LSG was also found, with a pooled SMD of 0.07 (95% CI: −0.10 to 0.24; $P = 0.41$). Similarly, the subgroup analysis results also showed no significant difference in long-term and midterm weight loss weight loss between LRYGB and LSG, with pooled SMDs of 0.11 (95% CI: −0.02 to 0.25; $P = 0.11$) and −0.41 (95% CI: −1.69 to 0.87; $P = 0.53$). The pooled analysis above was performed using a random-effects model because significant heterogeneity ($P_h < 0.1$) was detected among the studies (see Table 1).

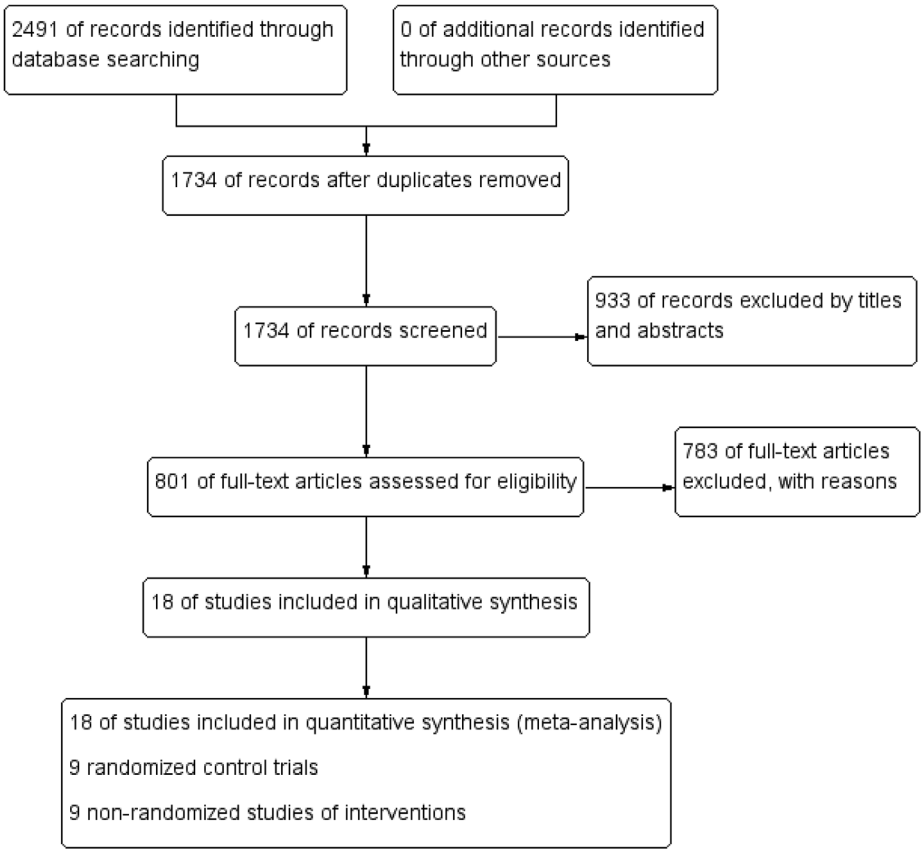

Fig. 1. Flow diagram of literature search and selection of included studies for meta-analysis.

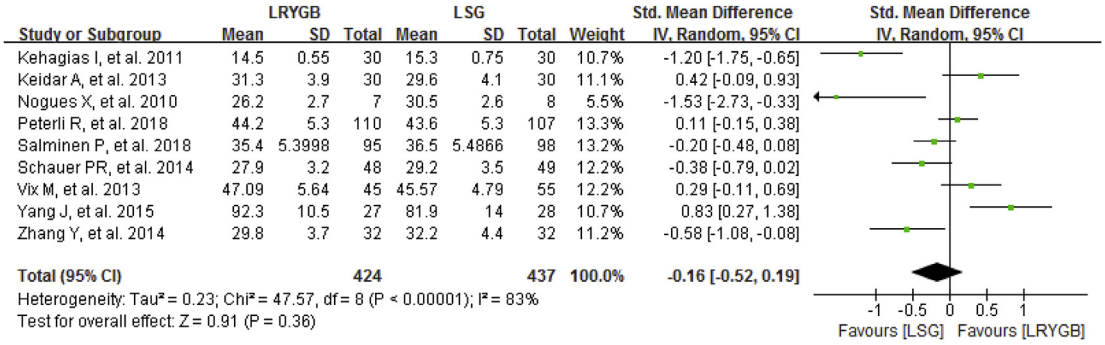

Fig. 2. Forest plot of comparison of excess weight loss between LRYGB and LSG based on RCTs.

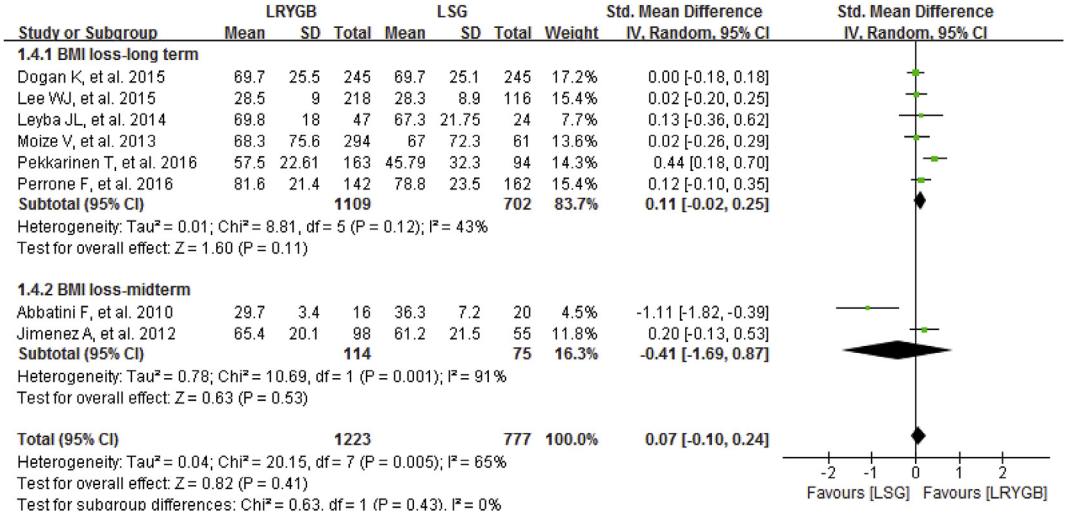

Fig. 3. Forest plot of comparison of excess weight loss between LRYGB and LSG based on NRSI.

3.3. Comparison of T2DM resolution between LRYGB and LSG

This study also compared and analysed the effect of LRYGB and LSG for resolving T2DM. Our pooled analysis showed that LRYGB and LSG had equal efficacy for T2DM remission based on RCTs, with pooled RRs of 1.07 (95% CI: 0.89 to 1.28; $P = 0.47$) for overall remission (Fig. 4), 1.06 (95% CI: 0.90 to 1.25; $P = 0.47$) for midterm remission and 1.18 (95% CI: 0.94 to 1.47; $P = 0.16$) for long-term resolution. In addition, no significant difference was found in T2DM improved (RR 0.57; 95% CI: 0.26 to 1.24; $P = 0.16$), unchanged (RR 0.93; 95% CI: 0.21 to 4.20; $P = 0.92$), and worsened (RR 0.42; 95% CI: 0.03 to 6.62; $P = 0.54$) (Table 2). The analysis was performed using a fixed-effect model, as no significant heterogeneity among the studies was found, except the analysis of T2DM worsened. In addition, as shown in Table 2, based on data from NRSI, results showed no significant difference in T2DM remission, with a pooled OR of 1.85 (95% CI: 1.00 to 3.44; $P = 0.05$) for overall remission. However, for midterm remission, it indicated that LRYGB was superior to LSG with a pooled OR of 1.92 (95% CI: 1.03 to 3.61; $P = 0.04$).

3.4. Comparison of complication and reoperation between LRYGB and LSG

Our pooled analysis showed that LRYGB had more complications after operation, with pooled RR of 1.59 (95% CI: 1.22 to 2.06; $P = 0.0006$) for overall complications (Fig. 5). Our subgroup analysis further indicated significant difference in early complication, with pooled RR of 2.14 (95% CI: 1.26 to 3.64; $P = 0.005$). However, no significant difference was found in late complication (RR 1.29; 95% CI:

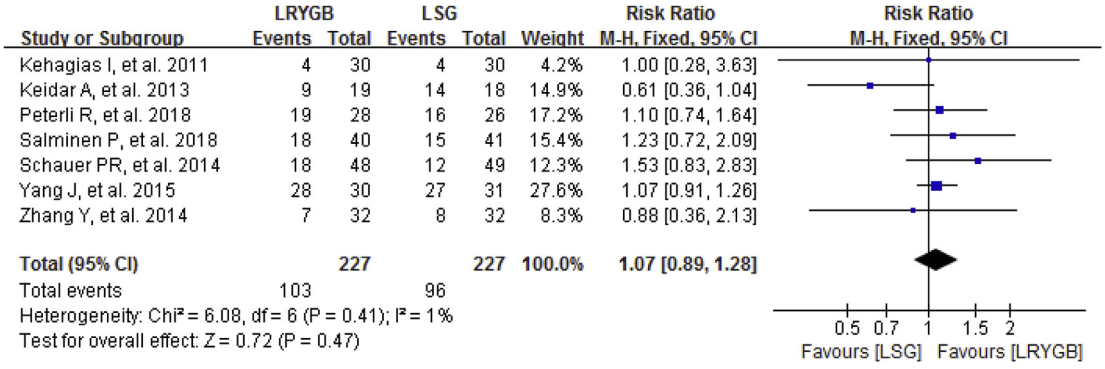

Fig. 4. Forest plot of comparison of T2DM remission between LRYGB and LSG based on RCTs.

Table 1
The characteristics of included studies for the analysis of LRYGB versus LSG for weight loss and resolution of co-morbidity.

Study (author/year)	Country	Study design	Sample size	Gender (M/F)	Mean age (range/SD)		BMI (kg/m^2)		Follow-up time (month)	Outcoms
					LRYGB	LSG	LRYGB	LSG		
Randomized control trials (RCTs)			LRYGB/LSG							
Kehagias I et al., 2011	Greece	RCT	30/30	16/44	36.0 (8.4)	33.7 (9.9)	45.8 (3.7)	44.9 (3.4)	36.0	BMI, T2DM, co-morbidities
Keidar A et al., 2013	Israel	parallel un-blinded RCT	30/30	21/39	51.45 (8.3)	47.7 (11.7)	42.0 (4.8)	42.5 (5.2)	12.0	BMI, T2DM, FBG
Nogues X et al., 2010	Spain	RCT	7/8	0/15	45.86 (8.6)	49.63 (9.6)	43.1 (3.9)	43.5 (3.2)	12.0	BMI, reoperation
Salminen P et al., 2018	Finland	multicenter, multisurgeon, open-label RCT	95/98	73/120	48.4 (9.3)	48.5 (9.6)	46.4 (5.9)	45.5 (6.2)	60.0	Excessweight loss, resolution of comorbidities, improvement of QoL, all AEs and mortality.
Schauer PR et al., 2014	US	RCT	48/49	31/66	48.0 (8.45)	47.8 (8.08)	37.1 (3.39)	36.1 (3.91)	36.0	BMI, T2DM, reoperation, LDL
Vix M et al., 2013	France	RCT	45/55	18/82	35.23 (9.37)	35.13 (9.7)	47.09 (5.64)	45.57 (4.79)	12.0	FBG, LDL
Yang J et al., 2015	China	RCT	27/28	22/33	41.4 (9.3)	40.4 (9.4)	32.3 (2.4)	31.8 (3)	36.0	BMI, T2DM, HTN, HLP
Zhang Y et al., 2014	China	RCT	32/32	26/38	32.2 (9.2)	29.3 (9.8)	39.3 (3.8)	38.5 (4.2)	60.0	BMI, T2DM, co-morbidities
Peterli R et al., 2018	Switzerland	Multicenter RCT	110/107	61/156	42.1 (11.2)	43.0 (11.1)	44.2 (5.3)	43.6 (5.3)	60.0	weight loss, changes in comorbidities, increase in QoL and AEs.
Non-randomised studies of interventions (NRSI)										
Abbatini F et al., 2010	Italy	Retrospective	16/20	11/25	53 (8.3)	46.6 (4.2)	47.4 (8.0)	51.6 (15.9)	36.0	BMI, HTN, HLP, HTG
Dogan K et al., 2015	Netherlands	Retrospective	245/245	88/402	41.2 (9.7)	39.7 (10.0)	47.2 (5.8)	45.8 (6.0)	37.2 (13.2)	BMI
Jammu GS et al., 2016	India	Prospective	33/23	30/25	38	23	42.5	35	53.5	BMI, T2DM, HTN, HLP
Jimenez A et al., 2012	Spain	Prospective	98/55	60/93	49.6 (8.2)	52.4 (9.1)	44.8 (4.6)	49.8 (7.2)	35.4 (13.5)	BMI, T2DM
Leyba JL et al., 2014	Venezuela	Prospective	47/24	22/49	38 (9.9)	34.6 (9.2)	42.1 (4.7)	41.1 (4.9)	60.0	BMI, T2DM
Moize V et al., 2013	Spain	Prospective	294/61	88/267	45.2 (10.6)	46.6 (11.6)	47.4 (6)	51.6 (6.7)	60	BMI
Pekkarinen T et al., 2016	Finland	Retrospective	163/94	92/165	47 (24–63)	49 (24–67)	49 (39–68)	47 (37–77)	82.2	BMI
Perrone F et al., 2016	Italy	Prospective	142/162	94/210	43.8 (4.6)	41.8 (4.6)	46.8 (3.6)	47.4 (4.2)	75.8 (8.4)	BMI, HLP
Lee WJ et al., 2015	China	Prospective	218/116	272/62	36.1 (9.3)	36.0 (9.1)	37.5 (6.0)	37.5 (6.1)	60.0	BMI

LRYGB, laparoscopic Roux-en-Y gastric bypass; LSG, laparoscopic sleeve gastrectomy; RCT, randomized control trial; NRSI, non-randomised studies of interventions; BMI, body mass index; T2DM, type 2 diabetes mellitus; AEs, adverse events; QoL, quality of life; SD, standard deviation; HTN, hypertension; HLP, hyperlipidemia; FBG, fasting blood glucose; LDL, Low Density Lipoprotein.

Table 2
The pooled results of the comparison of T2DM resolution between LRYGB and LSG.

Groups/subgroups	No. of studies	Pooled results			Heterogeneity		
		Estimate	95% CI	*P* value	I^2	P_h value	Analytical effect model
RCTs							
T2DM remission [6,10,11,21–26]	9	RR: 1.12	0.95, 1.33	0.16	0%	0.48	Fixed-effect model
Midterm remission [21,26]	2	RR: 1.06	0.90, 1.25	0.47	0%	0.83	Fixed-effect model
Long-term remission [6,10,11,21]	4	RR: 1.18	0.94, 1.47	0.16	0%	0.71	Fixed-effect model
T2DM improved [10,21]	2	RR: 0.57	0.26, 1.24	0.16	0%	0.76	Fixed-effect model
T2DM unchanged [10,21]	2	RR: 0.93	0.21, 4.20	0.92	0%	0.54	Fixed-effect model
T2DM worsened [10,21]	2	RR: 0.42	0.03, 6.62	0.54	68%	0.08	Random-effect model
NRSI							
T2DM remission [29,30,32]	3	OR: 1.85	1.00, 3.44	0.05	0%	0.74	Fixed-effect model
Midterm remission [29,30]	2	OR: 1.92	1.03, 3.61	0.04	0%	0.65	Fixed-effect model
Long-term remission [32]	1	OR: 0.56	0.01, 24.51	0.76	–	–	–

RCT, randomized control trial; NRSI, non-randomised studies of interventions; RR, risk ratio; OR, odds ratio; CI, confidence intervals; T2DM, type 2 diabetes mellitus.

0.88 to 1.88; $P = 0.19$). In addition, we also compared the reoperation rate of both comparative groups and found that patients received LRYGB may experience higher rate of reoperation with a pooled RR of 1.73 (95% CI: 1.14 to 2.62; $P = 0.01$) (Table 3). The analysis was performed using a fixed-effect model, as no significant heterogeneity among the studies was found.

3.5. Resolution of co-morbidities with LRYGB and LSG

We also compared LRYGB and LSG in terms of the resolution of comorbidities. The pooled results indicated LRYGB may be superior to LSG in dyslipidemia remission, with pooled RRs of 1.36 (95% CI: 1.17 to 1.59; $P < 0.0001$) for overall remission and 1.43 (95% CI: 1.19 to 1.72; $P = 0.0001$) for long-term remission. However, no difference was found in midterm dyslipidemia remission (RR 1.13; 95% CI: 0.93 to 1.38; $P = 0.23$) and in dyslipidemia unchanged (RR 0.50; 95% CI: 0.16 to 1.59; $P = 0.24$). LRYGB may also have higher hypertension remission rate, with pooed RRs of 1.23 (95% CI: 1.05 to 1.44; $P = 0.01$) for overall remission and 1.23 (95% CI: 1.04 to 1.45; $P = 0.01$) for long-term remission. However, in dyslipidemia midterm remission, improved and unchanged, there was no difference. In addition, we found that LRYGB may be superior to LSG in GERD improvement with pooled RR of 1.48 (95% CI: 1.07 to 2.04; $P = 0.02$). In contrast, LSG may worsen GERD symptoms and may lead to de novo GERD, with pooled RRs of 0.16 (95% CI: 0.06 to 0.44; $P = 0.0004$) and 0.33 (95% CI: 0.15 to 0.68; $P = 0.003$) respectively. No significant difference was found in the analysis of remission of OSAHS, back or joint pain, hyperuricemia and depression (Table 4).

3.6. Publication bias, sensitivity analysis and heterogeneity

We omitted each study individually to perform a sensitivity analysis and to examine the stability of the pooled results. As shown in Fig. 6, no significant effect was observed from the exclusion of any single study, and the pooled results indicated good stability, which was described in above paragraphs. In addition, to evaluate the heterogeneity of studies, we further prepared a Galbraith plot (Fig. 7) and found no significant between-study heterogeneity. Finally, we prepared Begg's funnel plot and Egger's publication bias plot for detecting publication bias. The absence of any significant asymmetry of plot suggested that no such bias occurred in the present analysis (Fig. 8).

4. Discussion and conclusion

Bariatric surgery has many benefits, including promoting weight loss and the resolution of T2DM and other comorbidities of obesity [36,37]. Weight loss is associated with short-term amelioration and prevention of metabolic and cardiovascular disorders, but whether these benefits persist over time is unknown. In addition, Sjöström et al. reported that bariatric surgery appears to be a more viable option for treating severe obesity compared with conventional therapy, being associated with long-term weight loss, improved lifestyle and, except for hypercholesterolemia, amelioration of risk factors present at baseline. Furthermore, the 2- and 10-year rates of recovery from diabetes, hypertriglyceridaemia, low levels of high-density lipoprotein cholesterol, hypertension and hyperuricemia were more favourable in the surgery group than in the control group, whereas recovery from hypercholesterolemia did not differ between the groups. Moreover, the surgery group had lower 2- and 10-year incidence rates of diabetes, hypertriglyceridaemia and hyperuricemia than the control group; no differences between the groups in the incidence of hypercholesterolemia and hypertension were detected [3]. LRYGB and LSG are the most commonly performed procedures in bariatric surgery. However, their weight loss efficacy in the mid- and long-term has not been compared. Thus, this study compared LRYGB and LSG in terms of mid- and long-term weight loss, and the resolution of comorbidities.

Our pooled analysis of both RCTs and NRSI data indicated that LRYGB and LSG had similar efficacy with respect to weight loss, including midterm and long-term weight loss. However, LSG showed a lower incidence of reoperation and postoperative complications,

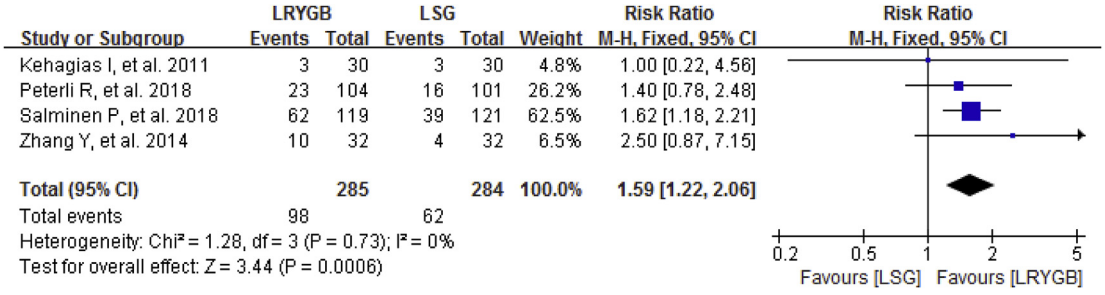

Fig. 5. Forest plot of comparison of complications between LRYGB and LSG based on RCTs.

Table 3
The pooled results of the complications after operation between LRYGB and LSG based on RCTs.

Groups/subgroups	Number of studies	Pooled results			Heterogeneity		
		RR	95% CI	*P* value	I^2	P_h value	Analytical effect model
Complications							
Early complications [10,11]	2	2.14	1.26, 3.64	0.005	0%	0.42	Fixed-effect model
Late complications [10,11]	2	1.29	0.88, 1.88	0.19	0%	0.69	Fixed-effect model
Overall complications [6,10,11,21]	4	1.59	1.25, 2.02	0.0001	0%	0.82	Fixed-effect model
Reoperation [6,10,11,21]	4	1.73	1.14, 2.62	0.010	0%	0.81	Fixed-effect model

RR, risk ratio; CI, confidence intervals.

especially in early complications defined as 0–30 days after operation. These early complications included in the sleeve gastrectomy obstruction, intra-abdominal abscess formation, pleural empyema, obstruction of the biliopancreatic limb and leakage at the gastrojejunostomy. In the study of Peterli R [10], one patient had a leakage at the gastrojejunostomy with a complicated course, which eventually led to multiorgan failure and death. In addition, LRYGB and LSG had similar efficacy in terms of both mid- and long-term resolution of T2DM, as well other comorbidities. Yip et al. compared T2DM remission and weight loss rates between patients with T2DM undergoing gastric bypass versus sleeve gastrectomy. Their analysis included 21 prospective studies (3 RCTs) and 12 retrospective studies, involving 1375 patients in total; no significant difference in either T2DM remission or weight loss was observed between gastric bypass and sleeve gastrectomy, which resulted in similar early T2DM remission rates at 3 months of 67% and 56%, respectively, with modest rates of additional T2DM remission thereafter; meanwhile, weight loss increased substantially between 3 and 12 months postoperatively, for both procedures [4]. LRYGB may be superior to LSG in dyslipidemia, hypertension and GERD remission. Our subgroup analysis further indicated that the superior effect of LRYGB in dyslipidemia, hypertension and GERD remission was only observed in long-term remission. No significance was found in midterm remission. Two RCTs were performed to compare the long-term efficacy of LRYGB and LSG with respect to BMI reduction and resolution of comorbidities in morbidly obese subjects, at least 5 years after surgery [10,11]. Peterli et al. performed an RCT that included 217 patients, and a 5-year follow-up, to determine any differences between SG and GBP in terms of weight loss, comorbidities, quality of life and adverse events [10]. There found no significant difference in the rate of BMI reduction at 5 years between SG and GBP (61.1% and 68.3%, respectively; absolute difference, −7.18%; 95% CI: −14.30% to −0.06%; $P = 0.22$ after adjusting for multiple comparisons). Gastric reflux remission was observed more frequently after GBP (60.4%) than after SG (25.0%). Gastric reflux worsened (more symptoms or therapy) more frequently after SG (31.8%) than after GBP (6.3%). There were 16 (of 101; 15.8%) and 23 (of 104; 22.1%) patients who underwent reoperations or interventions after SG and GBP, respectively [40]. In addition, a multicentre, multi-surgeon, open-label, randomised clinical equivalence trial

Table 4
The pooled results of the resolution of co-morbidities with LRYGB and LSG based on RCTs.

Outcomes	No. of studies	Pooled results			heterogeneity		
		RR	95% CI	*P* value	I^2	P_h value	Analytical effect model
Dyslipidemia							
Overall remission [6,10,11,21,26]	5	1.36	1.17, 1.59	< 0.0001	40%	0.14	Fixed-effect model
Midterm remission [21,26]	2	1.13	0.93, 1.38	0.23	0%	0.72	Fixed-effect model
Long-term remission [6,10,11]	3	1.43	1.19, 1.72	0.0001	34%	0.21	Fixed-effect model
Improved [10,11,21]	3	0.67	0.47, 0.95	0.03	0%	0.40	Fixed-effect model
Unchanged [10,11,21]	3	0.50	0.16, 1.59	0.24	68%	0.05	Random-effect model
Hypertension							
Overall remission [6,10,11,21,26]	5	1.23	1.05, 1.44	0.01	1%	0.41	Fixed-effect model
Midterm remission [21,26]	2	1.23	0.71, 2.15	0.46	14%	0.28	Fixed-effect model
Long-term remission [6,10,11]	3	1.23	1.04, 1.45	0.01	22%	0.28	Fixed-effect model
Improved [10,11,21]	3	0.80	0.59, 1.10	0.17	0%	0.82	Fixed-effect model
Unchanged [10,11,21]	3	0.62	0.37, 1.04	0.07	9%	0.33	Fixed-effect model
OSAHS							
Remission [10,21]	2	0.93	0.78, 1.12	0.46	0%	0.81	Fixed-effect model
Improved [10,21]	2	1.15	0.78, 1.69	0.49	0%	0.34	Fixed-effect model
Back or Joint Pain							
Remission [10,21]	2	0.93	0.72, 1.19	0.57	0%	0.68	Fixed-effect model
Improved [10,21]	2	1.03	0.76, 1.40	0.85	52%	0.15	Fixed-effect model
Unchanged [10,21]	2	1.30	0.18, 9.27	0.79	84%	0.01	Random-effect model
Worsened [10,21]	2	0.87	0.22, 3.41	0.84	0%	0.49	Fixed-effect model
GERD							
GERD remission [10,21]	2	1.68	0.86, 3.29	0.13	79%	0.03	Random-effect model
GERD improved [10,21]	2	1.48	1.07, 2.04	0.02	7%	0.34	Fixed-effect model
GERD unchanged [10,21]	2	0.67	0.38, 1.17	0.16	0%	0.35	Fixed-effect model
GERD worsened [10,21]	2	0.16	0.06, 0.44	0.0004	0%	0.59	Fixed-effect model
de novo GERD [10,21]	2	0.33	0.15, 0.68	0.003	0%	0.86	Fixed-effect model
Hyperuricemia remission [10,21]	2	1.11	0.78, 1.59	0.55	80%	0.02	Random-effect model
Depression							
Remission [10,21]	2	0.98	0.52, 1.88	0.96	2%	0.31	Fixed-effect model
Improved [10,21]	2	2.07	0.24, 17.61	0.51	78%	0.03	Random-effect model
Unchanged [10,21]	2	0.76	0.32, 1.79	0.53	58%	0.12	Fixed-effect model

RR, risk ratio; CI, confidence intervals; OSAHS, obstructive sleep apnea hypopnea syndrome; GERD, gastroesophageal reflux disease.

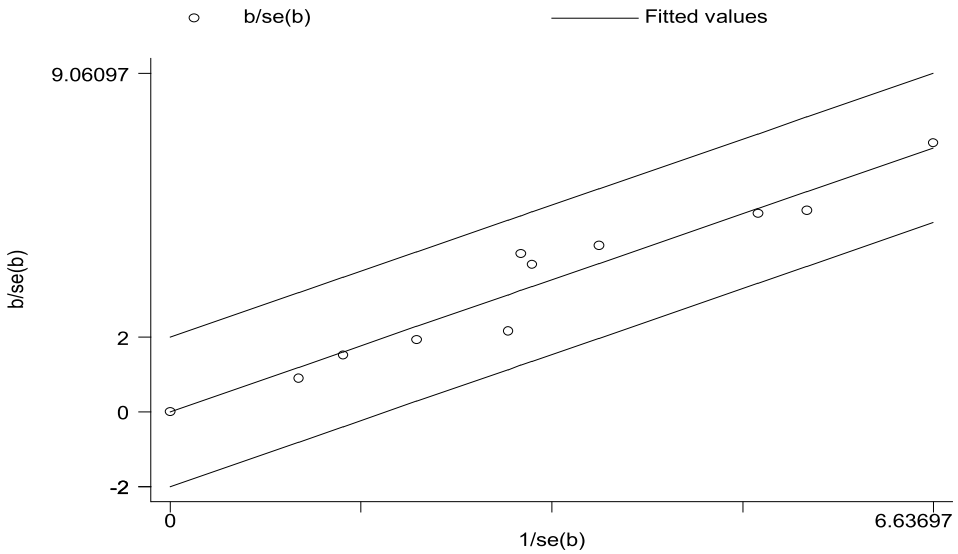

Fig. 6. Galbraith plot for detecting heterogeneity between LRYGB and LSG.

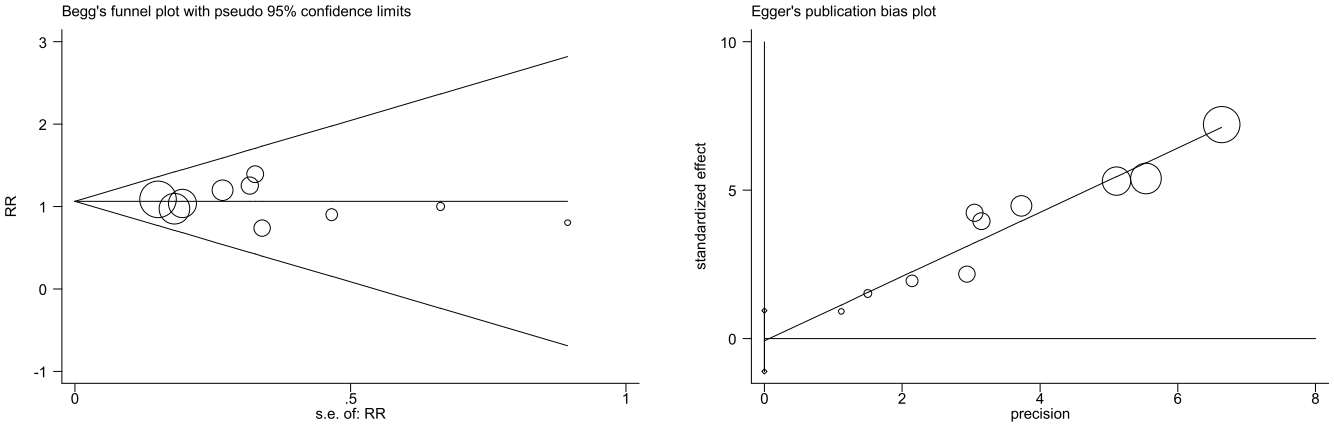

Fig. 7. Begg's funnel plot and Egger's publication bias plot for detecting publication bias of RCT studies.

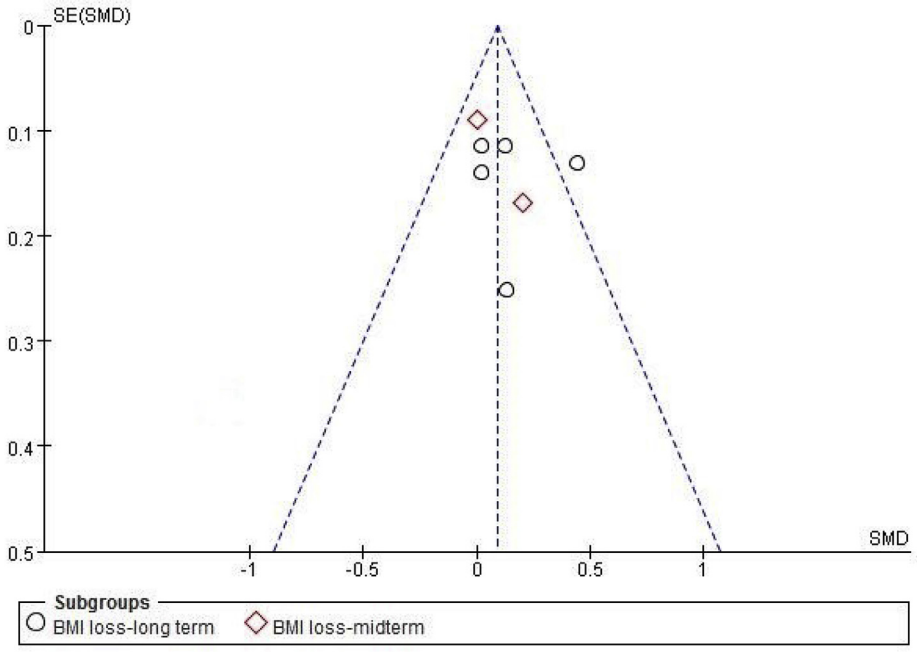

Fig. 8. Begg's funnel plot and Egger's publication bias plot for detecting publication bias of NRSI studies.

enrolling 240 morbidly obese patients aged 18–60 years was conducted by Salminen et al., to determine whether LSG and LGB are equivalent in terms of weight loss outcomes at 5 years in patients with morbid obesity [10]. That study included 240 patients, and 80.4% completed the 5-year follow-up. Their results showed that although GBP was associated with a greater likelihood of weight loss at 5 years, the difference was not significant [11]. Lee Y et al. (2019) indicated that LRYGB resulted in greater loss of body mass index compared to LSG at 1 year [MD -1.25 kg/m^2, 95% CI -2.01 to −0.49, $P = 0.001$] which persisted at 3 years, but there was insufficient evidence at 5 years. Resolution of dyslipidemia was higher for LRYGB than LSG at 1 year (RR 0.58, 95% CI 0.46 to 0.73, $P < 0.001$) and 5 years (RR 0.68, 95%CI 0.46 to 0.99, $P = 0.04$). There was no difference between LRYGB and LSG for remission of T2DM, hypertension, and hemoglobin A1c, fasting insulin, homeostatic model assessment of insulin resistance, high-density lipoprotein, and the rate of 30-day major and minor complications [38]. However, our results indicated a higher incidence of complications and reoperation rate in LRYGB. Wang Y et al. (2019) compared RYGB and SG used for super obesity (SO) and super super obesity (SSO), and indicated that RYGB achieved higher excess weight loss (%EWL) at 12 months, but no significant difference at 24 months. Resolution of diabetes mellitus and dyslipidemia reached a statistical significance; however, there was no significant difference in hypertension [39]. Another meta-analysis from Lee Y et al. (2019) of six retrospective cohort studies compared the efficacy and safety between single-anastomosis duodeno-ileal bypass (SADI) or biliopancreatic diversion with duodenal switch (BPD-DS) versus Roux-en-Y gastric bypass (RYGB) as a revisional procedure for SG and came to a conclusion that SADI, BPD-DS, and RYGB are safe and efficacious revisional surgeries for SG. Both SADI and RYGB were efficacious in lowering initial BMI but there was more evidence for excellent weight loss outcomes with the conversion to BPD-DS when the starting BMI is high [40]. Wu C et al.(2019) indicated that the patients in RYGB groups showed increased percent % EWL at 12 and 24 months after revision surgery but no statistically significant change was found about %EWL after 3, 6, or 36 months. In addition, RYGB was associated with a higher rate of complications, interventions, and readmission in addition to being of more operative time and this was consistent with our analysis results [41]. When considering these results as well as our analysis, a general conclusion about the efficacy and safety between LRYGB and LSG cannot be drawn at present. These results indicated both LRYGB and LSG have their advantages and disadvantages.

Our study had several limitations, the most serious of which was the variation in sample size among the included studies. Although we analysed 2917 participants, the sample size ranged widely among the studies, from 15 to 238 patients, which may have constituted a bias. In addition, the ages and preoperative BMIs of the included patients also varied widely, which may have led to heterogeneity. Though significant difference was found in reoperation rate, limited by the number of studies, we failed to conduct subgroup analysis to explore midterm or long-term reoperation rate as well as different cause of reoperation. For the analysis of resolution of co-morbidities, the number of studies included was small and this may result in bias of the pooled results. Additional, more rigorous studies are needed to determine the relative long-term efficacy of different bariatric surgeries.

In conclusion, the present meta-analysis indicated that both LRYGB and LSG are equivalent for excess weight loss and T2DM resolution. However, patients receiving LSG experienced fewer postoperative complications and reoperation rate than those who underwent LRYGB. In contrast, LRYGB may be superior in long-term remission of dyslipidemia and hypertension. LRYGB may be beneficial to GERD improvement but LSG may worsen GERD symptoms and may lead to de novo GERD. Base on this conclusion, when choose the type of operation, the main determinant should be the co-morbidities such as dyslipidemia, hypertension and GERD of patients, not the BMI or T2DM. Future studies should focus on the comparison of complication and co-morbidities.

Ethical Approval

Ethical Approval is not applicable.

Sources of funding

There is no funding for this work.

Author contribution

The authors on this paper all participated in study design. All authors have read and approved this version of the article, and due care has been taken to ensure the integrity of the work. The material of this article is original research and no part of this paper has been previously published. The material has also not been submitted for publication elsewhere while under consideration. No conflict of interest exits in the submission of this manuscript. All authors have the appropriate permissions and rights to the reported data.

Trial registry number

Research Registry
Reviewregistry687
https://www.researchregistry.com/browse-the-registry#registryofsystematicreviewsmeta-analyses/registryofsystematicreviewsmeta-analysesdetails/5cced3bb40d1d70006fc61a1/

Guarantor

Youkui Han.

Provenance and peer review

Not commissioned, externally peer-reviewed.

Data statement

The material of this article is original research. All data in this manuscript is available and transparent for readers.

Declaration of competing interest

The authors declare no relevant conflict of interest.

Acknowledgement

No further acknowledgement.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijsu.2020.02.035.

Abbreviations

T2DM	type 2 diabetes mellitus
BMI	body mass index
LRYGB	laparoscopic Roux-en-Y gastric bypass
LSG	laparoscopic sleeve gastrectomy
RR	risk ratio
CI	confidence intervals
OR	odds ratio
SMD	standard mean difference

RCT	randomized control trial
NRSI	non-randomised studies of interventions
AEs	adverse events
QoL	quality of life
SD	standard deviation
HTN	hypertension
HLP	hyperlipidemia
FBG	fasting blood glucose
LDL	low density lipoprotein
OSAHS	obstructive sleep apnea hypopnea syndrome
GERD	gastroesophageal reflux disease
SADI	single-anastomosis duodeno-ileal bypass
BPD-DS	biliopancreatic diversion with duodenal switch
SO	super obesity
SSO	super super obesity
EWL	excess weight loss

References

[1] H. Buchwald, Consensus conference statement bariatric surgery for morbid obesity: health implications for patients, health professionals, and third-party payers, Surg. Obes. Relat. Dis. 1 (3) (2005) 371–381.

[2] S.H. Chang, C.R.T. Stoll, J. Song, et al., The effectiveness and risks of bariatric surgery: an updated systematic review and meta-analysis, 2003-2012, JAMA Surg 149 (3) (2014) 275–287.

[3] L. Sjostrom, A.K. Lindroos, M. Peltonen, et al., Lifestyle, diabetes, and cardiovascular risk factors 10 years after bariatric surgery, N. Engl. J. Med. 351 (26) (2004) 2683–2693.

[4] S. Yip, L.D. Plank, R. Murphy, Gastric bypass and sleeve gastrectomy for type 2 diabetes: a systematic review and meta-analysis of outcomes, Obes. Surg. 23 (12) (2013) 1994–2003.

[5] E.E. Johnson, A.N. Simpson, J.B. Harvey, et al., Trends in bariatric surgery, 2002-2012: do changes parallel the obesity trend? Surg. Obes. Relat. Dis. 12 (2) (2016) 398–404.

[6] Y. Zhang, H. Zhao, Z. Cao, et al., A randomized clinical trial of laparoscopic Roux-en-Y gastric bypass and sleeve gastrectomy for the treatment of morbid obesity in China: a 5-year outcome, Obes. Surg. 24 (10) (2014) 1617–1624.

[7] A. Abdemur, S.M. Han, E.L. Menzo, et al., Reasons and outcomes of conversion of laparoscopic sleeve gastrectomy to Roux-en-Y gastric bypass for nonresponders, Surg. Obes. Relat. Dis. 12 (1) (2016) 113–118.

[8] J. Homan, B. Betzel, E.O. Aarts, et al., Secondary surgery after sleeve gastrectomy: roux-en-Y gastric bypass or biliopancreatic diversion with duodenal switch, Surg. Obes. Relat. Dis. 11 (4) (2015) 771–777.

[9] J. Thereaux, C. Roche, J.P. Bail, Laparoscopic conversion of sleeve gastrectomy to gastric bypass for super-obesity (BMI > /= 50 kg/m(2)) and incisional hernia: a video report, Obes. Surg. 26 (1) (2016) 239–240.

[10] R. Peterli, B.K. Wölnerhanssen, T. Peters, et al., Effect of laparoscopic sleeve gastrectomy vs laparoscopic roux-en-Y gastric bypass on weight loss in patients with morbid obesity: the SM-BOSS randomized clinical trial, Jama 319 (3) (2018) 255–265.

[11] P. Salminen, M. Helmiö, J. Ovaska, et al., Effect of laparoscopic sleeve gastrectomy vs laparoscopic roux-en-Y gastric bypass on weight loss at 5 Years among patients with morbid obesity: the SLEEVEPASS randomized clinical trial, Jama 319 (3) (2018) 241–254.

[12] H.D. Clark, G.A. Wells, C. Huët, et al., Assessing the quality of randomized trials: reliability of the Jadad scale, Contr. Clin. Trials 20 (5) (1999) 448–452.

[13] A. Stang, Critical evaluation of the Newcastle-Ottawa scale for the assessment of the quality of nonrandomized studies in meta-analyses, Eur. J. Epidemiol. 25 (9) (2010) 603–605.

[14] Review Manager (RevMan) [Computer Program]. Version 5.2, The Nordic Cochrane Centre, The Cochrane Collaboration, Copenhagen, 2012.

[15] J. Lau, J.P. Ioannidis, C.H. Schmid, Quantitative synthesis in systematic reviews, Ann. Intern. Med. 127 (9) (1997) 820–826.

[16] University of York Centre for Reviews and Dissemination, Systematic Reviews: CRD's Guidance for Undertaking Reviews in Health Care, CRD, University of York, York, 2009.

[17] R. DerSimonian, N. Laird, Meta-analysis in clinical trials. Control, Clin. Trials 7 (3) (1986) 177–188.

[18] N. Mantel, W. Haenszel, Statistical aspects of the analysis of data from retrospective studies of disease, J. Natl. Cancer Inst. 22 (4) (1959) 719–748.

[19] D. Moher, A. Liberati, J. Tetzlaff, et al., The PRISMA group (2009) preferred reporting Items for systematic reviews and meta-analyses: the PRISMA statement, PLoS Med. 6 (7) (2009) e1000097.

[20] B.J. Shea, B.C. Reeves, G. Wells, et al., AMSTAR 2: a critical appraisal tool for systematic reviews that include randomised or non-randomised studies of healthcare interventions, or both, BMJ 21 (2017) 358:j4008.

[21] I. Kehagias, S.N. Karamanakos, M. Argentou, et al., Randomized clinical trial of laparoscopic Roux-en-Y gastric bypass versus laparoscopic sleeve gastrectomy for the management of patients with BMI < 50 kg/m^2, Obes. Surg. 21 (11) (2011) 1650–1656.

[22] A. Keidar, K.J. Hershkop, L. Marko, et al., Roux-en-Y gastric bypass vs sleeve gastrectomy for obese patients with type 2 diabetes: a randomised trial, Diabetologia 56 (9) (2013) 1914–1918.

[23] X. Nogues, A. Goday, M.J. Peña, et al., Bone mass loss after sleeve gastrectomy: a prospective comparative study with gastric bypass, Cir. Esp. 88 (2) (2010) 103–109.

[24] P.R. Schauer, D.L. Bhatt, J.P. Kirwan, et al., Bariatric surgery versus intensive medical therapy for diabetes–3-year outcomes, N. Engl. J. Med. 370 (21) (2014) 2002–2013.

[25] M. Vix, M. Diana, K.H. Liu, et al., Evolution of glycolipid profile after sleeve gastrectomy vs. Roux-en-Y gastric bypass: results of a prospective randomized clinical trial, Obes. Surg. 23 (5) (2013) 613–621.

[26] J. Yang, C. Wang, G. Cao, et al., Long-term effects of laparoscopic sleeve gastrectomy versus roux-en-Y gastric bypass for the treatment of Chinese type 2 diabetes mellitus patients with body mass index 28-35 kg/m(2), BMC Surg. 15 (2015) 88.

[27] F. Abbatini, M. Rizzello, G. Casella, et al., Long-term effects of laparoscopic sleeve gastrectomy, gastric bypass, and adjustable gastric banding on type 2 diabetes, Surg. Endosc. 24 (5) (2010) 1005–1010.

[28] K. Dogan, R.P.M. Gadiot, E.O. Aarts, et al., Effectiveness and safety of sleeve gastrectomy, gastric bypass, and adjustable gastric banding in morbidly obese patients: a multicenter, retrospective, matched cohort study, Obes. Surg. 25 (7) (2015) 1110–1118.

[29] G.S. Jammu, R. Sharma, A 7-year clinical audit of 1107 cases comparing sleeve gastrectomy, roux-en-Y gastric bypass, and mini-gastric bypass, to determine an effective and safe bariatric and metabolic procedure, Obes. Surg. 26 (5) (2016) 926–932.

[30] A. Jimenez, R. Casamitjana, L. Flores, et al., Long-term effects of sleeve gastrectomy and Roux-en-Y gastric bypass surgery on type 2 diabetes mellitus in morbidly obese subjects, Ann. Surg. 256 (6) (2012) 1023–1029.

[31] W.J. Lee, E.H. Pok, A. Almulaifi, et al., Medium-term results of laparoscopic sleeve gastrectomy: a matched comparison with gastric bypass, Obes. Surg. 25 (8) (2015) 1431–1438.

[32] J.L. Leyba, S.N. Llopis, S.N. Aulestia, Laparoscopic Roux-en-Y gastric bypass versus laparoscopic sleeve gastrectomy for the treatment of morbid obesity. a prospective study with 5 years of follow-up, Obes. Surg. 24 (12) (2014) 2094–2098.

[33] V. Moize, A. Andreu, L. Flores, et al., Long-term dietary intake and nutritional deficiencies following sleeve gastrectomy or Roux-En-Y gastric bypass in a mediterranean population, J. Acad. Nutr. Diet. 113 (3) (2013) 400–410.

[34] T. Pekkarinen, H. Mustonen, T. Sane, et al., Long-term effect of gastric bypass and sleeve gastrectomy on severe obesity: do preoperative weight loss and binge eating behavior predict the outcome of bariatric surgery? Obes. Surg. 26 (9) (2016) 2161–2167.

[35] F. Perrone, E. Bianciardi, D. Benavoli, et al., Gender influence on long-term weight loss and comorbidities after laparoscopic sleeve gastrectomy and roux-en-Y gastric bypass: a prospective study with a 5-year follow-up, Obes. Surg. 26 (2) (2016) 276–281.

[36] E. Climent, D. Benaiges, J. Pedro-Botet, et al., Laparoscopic Roux-en-Y gastric bypass vs. laparoscopic sleeve gastrectomy for morbid obesity: a systematic review and meta-analysis of lipid effects at one year postsurgery, Minerva Endocrinol. 43 (1) (2018) 87–100.

[37] S. Shoar, A.A. Saber, Long-term and midterm outcomes of laparoscopic sleeve gastrectomy versus Roux-en-Y gastric bypass: a systematic review and meta-analysis of comparative studies, Surg. Obes. Relat. Dis. 13 (2) (2017) 170–180.

[38] Y. Lee, A.G. Doumouras, J. Yu, et al., Laparoscopic Sleeve Gastrectomy versus Laparoscopic Roux-En-Y Gastric Bypass: A Systematic Review and Meta-Analysis of Weight Loss, Comorbidities, and Biochemical Outcomes from Randomized Controlled Trials, (2019) [epub ahead of print]. Ann Surg.

[39] Y. Wang, Y.H. Song, J. Chen, et al., Roux-en-Y gastric bypass versus sleeve gastrectomy for super super obese and super obese: systematic review and meta-analysis of weight results and comorbidity resolution, Obes. Surg. 29 (6) (2019) 1954–1964.

[40] Y. Lee, Y. Ellenbogen, A.G. Doumouras, et al., Single- or double-anastomosis duodenal switch versus Roux-en-Y gastric bypass as a revisional procedure for sleeve gastrectomy: a systematic review and meta-analysis, Surg. Obes. Relat. Dis. 15 (4) (2019) 556–566.

[41] C. Wu, F.G. Wang, W.M. Yan, et al., Clinical outcomes of sleeve gastrectomy versus roux-en-Y gastric bypass after failed adjustable gastric banding, Obes. Surg. 29 (10) (2019) 3252–3263.