Effects and resource implications of one anastomosis gastric bypass procedure in comparison to sleeve gastrectomy and roux n y gastric bypass in obese patients: A systematic review and meta-analysis.

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DECLARATION

I, *Dr Rufaro Kashangura Majirija,* hereby declare that the work on which this dissertation/thesis is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other university.

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Abbreviations

Body mass Index	BMI
Glucagon-like peptide	GLP-1
Human immunodeficiency virus	HIV
Diabetis Mellitus	DM
Type 2 Diabetis Mellitus	T2DM
One anastomosis gastric bypass	OAGB
Roux n Y gastric bypass	RYGB
Randomised controlled trials	RCT
Quality of life	QOL
Estimated weight loss	EWL
Mean operating time	MOT
Length of stay	LOS
Quality-Adjusted Life Years	QALYs
Disability- Adjusted Life Years	DALYs
Risk of bias	ROB
Confidence intervals	CIs
Systematic review	SR
Loss to follow up	LTFU
Gastroesophageal reflux disease	GERD
Intention to treat	ITT
Modified intention to treat	MITT
Biliopancreatic limb	BPL
Alimentary limb	AL

Abstract

Background

One anastomosis gastric bypass (OAGB) is a proposed alternative to Roux n Y gastric bypass (RYGB) and sleeve gastrectomy (LSG) which are the main bariatric operations in many centres. It is a restrictive and malabsorptive weight loss surgery thought to be simpler, having a small learning curve and shorter intraoperative time. However, its effects and safety compared to other methods remains uncertain.

Objectives

We aim to evaluate the available evidence from randomised controlled trials (RCTs) on effects, resource input and safety of OAGB in comparison to LSG and RYGB in obese adults and children, with a view of ascertaining the optimal technique especially in resource constrained environments.

Methods

We searched MEDLINE (PubMed); Embase (Ovid); Central Register of Controlled Trials (CENTRAL, Cochrane Library); Web of Science Core Collection, specifically Science Citation Index Expanded, Social Sciences Citation Index, Conference Proceedings Citation Index (Clarivate); CINAHL (EBSCOHost); Scopus; LILACS (Virtual Health Library) from Jan 2001 when OAGB was first described to August 2021. We identified all RCTs regardless of language or publication status using two search strategies, the primary strategy relating to effects and safety and the complementary strategy for health economic evaluations.

We included all RCTs with adults or children with body mass index (BMI) greater than 40 or greater than 35 with comorbidities comparing OAGB to either LSG or RYGB with effects, safety, or resource implication data.

Two authors independently identified the studies for inclusion, collected the data and assessed the risk of bias (ROB). We performed the meta-analyses using the Review Manager 5.4. We calculated the risk ratio (RR) for dichotomous outcomes and mean difference (MD) for continuous outcomes with 95% confidence intervals and used the random - effects model. Where meta-analysis was inappropriate or not possible a narrative synthesis was given. We used the Cochrane ROB-2 tool to assess for ROB. We used GRADE to assess the certainty of evidence for the outcomes in the summary of findings.

Results

From 7 271 studies we included 34 studies; 10 being published data,12 conference abstracts and 13 ongoing trials one of them with preliminary results. All participants

were adults. None of the studies in the review reported on cost of the procedure or any surgery related mortality.

OAGB vs LSG

Total of 147 patients in the OAGB arm were compared to 146 in the LSG arm in 5 included studies (1 study had 3 publications at 1, 3 and 5 years). OAGB results in little or no difference in comorbid resolution compared to LSG for all outcomes except hypertension and diabetes at 5 years where OAGB likely results in large increase in complete diabetes resolution; RR 1.5 (1.10, 2.04). and hypertension RR 1.51 (1.03, 2.19), low evidence from one trial. OAGB likely results in large increase in estimated weight loss percentage (EWL%) consistently up to five years where EWL% is -9.34 (-16.39, -2.29), 5 RCTs, 635 participants. Operation time is likely longer compared with LSG MD 19.04 minutes (6.49%, 31.6%), 3 RCTs, 304 participants, moderate certainty evidence. OAGB may result in an increase in bile reflux RR 1.5 (0.58, 3.88) though the evidence remains uncertain. OAGB may result in more malnutrition compared to LSG RR 2.09 (0.94, 4.63), 3 RCTs, 234 participants, low certainty evidence. Recidivism was only in 3 patients in 2 RCTS after LSG compared to OAGB, moderate certainty evidence of little or no difference. OAGB likely results in slightly better quality of life scores (QOL) including comorbidities compared to LSG up to 5 years. At 5 years, QOL is likely better after OAGB with or without comorbidities.

OAGB vs RYGB

Two hundred and forty-four participants had OAGB vs 254 in RYGB in 5 included studies. OAGB may result in little to no difference in comorbid resolution at 1 year: complete diabetic remission RR 0.86 (0.67, 1.10), 2 RCTs moderate certainty evidence. OAGB may result in increased EWL% compared to RYGB MD -4.93% (-7.88%, -1.99%), 5 RCTs, 575 participants. Operation time is likely shorter with OAGB compared to RYGB MD -34.3 (-45.76, - 22.84) minutes with little or no difference in length of stay. OAGB likely results in large increase in bile reflux compared to RYGB RR 17.25 (3.13, 94.97), 3 RCTs, 322 participants with 1 report of intestinal metaplasia in the OAGB arm. The evidence is very uncertain from 2 RCTs, 128 participants about the effect of OAGB on malnutrition rates compared to RYGB: RR 2.28 (0.13, 40.45). There is little or no difference in QOL and reoperation rates compared to RYGB.

Conclusion

Except for weight loss and operative times, the evidence remains uncertain comparing the effects and safety of these 3 methods. OAGB remains an option that can be used for bariatric surgery with non-inferior comorbid resolution and quality of life and no surgery related mortality. However, there are still concerns of likely increase in bile reflux and no evidence of effect on malnutrition after surgery. More RCTs with larger sample sizes in low-income areas are needed to explore these outcomes further. More long-term studies will explore the possibility of development of gastric cancer. None of the studies reported on cost of the procedures to inform decision making in low-income area.

Summary of findings

Summary of findings:

OAGB compared to LSG for Obesity

Patient or population: BMI greater than 40 or greater than 35 with comorbidities.
Setting:
Intervention: OAGB
Comparison: LSG

Outcome № of participants (studies)	Relative effect (95% CI)	Anticipated absolute effects (95% CI)			Certainty	What happens
				Difference		
Complete diabetic resolution assessed with: HbAIC < 6.5 without medications follow-up: 1 year № of participants: 131 (3 RCTs)	**RR 1.16** (0.89 to 1.53)	**Study population**			⊕⊕◯◯ Low[b, c]	OAGB may result in little or no difference in complete diabetic resolution compared to LSG after 1yr of having the procedure
		69.4%	**80.5%** (61.7 to 100)	**11.1% more** (7.6 fewer to 36.8 more)		
		Low				
		40.0%[a]	**46.4%** (35.6 to 61.2)	**6.4% more** (4.4 fewer to 21.2 more)		
		High				
		80.0%[a]	**92.8%** (71.2 to 100)	**12.8% more** (8.8 fewer to 42.4 more)		
Complete diabetic resolution assessed with: HbAIc < 6.5 without medications follow-up: 5 years № of participants: 77 (1 RCT)	**RR 1.50** (1.10 to 2.04)	56.8%	**85.1%** (62.4 to 100)	**28.4% more** (5.7 more to 59 more)	⊕⊕◯◯ Low[d, e]	OAGB may result in large increase in diabetic resolution after 5 years compared to LSG
Weight loss OAGB vs LSG assessed with: Estimated weight loss % follow-up:	-	The mean weight loss OAGB vs LSG was **-55 to -76** %[g]	-	MD **12.81 % lower** (13.99 lower to 11.64 lower)	⊕⊕⊕◯ Moderate[b, d]	OAGB likely results in large increase in EWL % than LSG

Summary of findings:

OAGB compared to LSG for Obesity

Patient or population: BMI greater than 40 or greater than 35 with comorbidities.
Setting:
Intervention: OAGB
Comparison: LSG

Outcome № of participants (studies)	Relative effect (95% CI)	Anticipated absolute effects (95% CI)			Certainty	What happens
				Difference		
range 1 to 5 years № of participants: 635 (5 RCTs)						
Operation time assessed with: Minutes № of participants: 304 (3 RCTs)	-	The mean operation time ranged from **45 to 68** minutes	-	MD **19.04 minutes higher** (6.49 higher to 31.6 higher)	⨁⨁⨁◯ Moderate[b]	OAGB likely results in increase in operation time compared to LSG.
Bile reflux assessed with: Symptomatic reflux and endoscopy follow-up: 1 year № of participants: 264 (2 RCTs)	**RR 1.50** (0.58 to 3.88)	**Study population**			⨁⨁◯◯ Low[b, c]	The evidence is uncertain about the effect of OAGB on bile reflux compared to RYGB, but OAGB may cause an increase in bile reflux compared to LSG.
		4.5%	**6.8%** (2.6 to 17.6)	**2.3% more** (1.9 fewer to 13.1 more)		
		Low				
		2.0%[f]	**3.0%** (1.2 to 7.8)	**1.0% more** (0.8 fewer to 5.8 more)		
		High				
		20.0%[f]	**30.0%** (11.6 to 77.6)	**10.0% more** (8.4 fewer to 57.6 more)		
Malnutrition № of participants: 234 (3 RCTs)	**RR 2.09** (0.94 to 4.63)	**Study population**			⨁⨁◯◯ Low[b, c]	OAGB may result in moderate increase in malnutrition compared to LSG post procedure.
		6.0%[h]	**12.6%** (5.7 to 27.9)	**6.6% more** (0.4 fewer to 21.9 more)		
		Moderate				

Summary of findings:

OAGB compared to LSG for Obesity

Patient or population: BMI greater than 40 or greater than 35 with comorbidities.
Setting:
Intervention: OAGB
Comparison: LSG

Outcome № of participants (studies)	Relative effect (95% CI)	Anticipated absolute effects (95% CI)			Certainty	What happens
				Difference		
		10.0%	**20.9%** (9.4 to 46.3)	**10.9% more** (0.6 fewer to 36.3 more)		
Recidivism follow-up: 1 years № of participants: 234 (2 RCTs)	**RR 0.25** (0.03 to 2.16)	**Study population**			⨁⨁◯◯ Low[c, i, j]	OAGB may result in little or no difference in recidivism compared to LSG.
		2.6%	**0.6%** (0.1 to 5.6)	**1.9% fewer** (2.5 fewer to 3 more)		
		Low				
		1.0%	**0.3%** (0 to 2.2)	**0.8% fewer** (1 fewer to 1.2 more)		
		High				
		10.0%	**2.5%** (0.3 to 21.6)	**7.5% fewer** (9.7 fewer to 11.6 more)		

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: confidence interval; **MD:** mean difference; **RR:** risk ratio

GRADE Working Group grades of evidence
High certainty: we are very confident that the true effect lies close to that of the estimate of the effect.
Moderate certainty: we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low certainty: our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.
Very low certainty: we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.

Explanations

a. The low and high percentages of diabetic resolution are the extreme values in the control group
b. Downgraded one level for unclear ROB in one study with no information on randomisation, allocation concealment, blinding and definition of comorbid resolution: other study high risk with no blinding of outcome assessors.
c. Downgraded one level for imprecision as confidence level includes value of no effect.
d. Downgraded one level due to high ROB from unblinded investigators and outcome assessors and large loss to follow up of more than 25% in each arm.
e. Though result precise showing better diabetic resolution, the result is from one study with small sample size hence we downgraded by one level
f. The low and high values are the extreme values in the control arm
g. The low and high weight loss are the extreme values of weight loss in the control arm

h. Value in the only control group with an outcome
i. Downgraded two levels for definition of weight regain not given and selective outcome reporting of weight regain not actually found in paper covering reporting timeline. However due to consistency of results we will only downgrade one level

Summary of findings:

OAGB compared to RYGB for Obesity

Patient or population: BMI greater than 40 or greater than 35 with comorbidities.
Setting:
Intervention: OAGB
Comparison: RYGB

Outcome № of participants (studies)	Relative effect (95% CI)	Anticipated absolute effects (95% CI)			Certainty	What happens
				Difference		
Complete Diabetes resolution assessed with: HbAlc < 6.5 and off medications follow-up: 1 № of participants: 51 (2 RCTs)	**RR 0.86** (0.67 to 1.10)	**Study population**			⨁⨁⨁◯ Moderate[b]	OAGB likely results in little or no difference in complete diabetes resolution at 1 year compared to RYGB.
		88.0%	**75.7%** (59 to 96.8)	**12.3% fewer** (29 fewer to 8.8 more)		
		Low				
		40.0%[a]	**34.4%** (26.8 to 44)	**5.6% fewer** (13.2 fewer to 4 more)		
		High				
		100.0%[a]	**86.0%** (67 to 100)	**14.0% fewer** (33 fewer to 10 more)		
Weight loss assessed with: Estimated weight loss percentage EWL% follow-up: range 1 to 5 years № of participants: 575 (5 RCTs)	-	The mean weight loss was **-1.6 to 11.7**	-	MD **4.93 lower** (7.88 lower to 1.99 lower)	⨁⨁◯◯ Low[c, d]	OAGB may result in more EWL% than RYGB
Operation time assessed with: Minutes № of participants: 486 (5 RCTs)	-	The mean operation time was **111 - 205** Min	-	MD **34.3 Min lower** (45.76 lower to 22.84 lower)	⨁⨁⨁◯ Moderate[e]	OAGB likely results in large decrease in operation time compared to RYGB.

Summary of findings:

OAGB compared to RYGB for Obesity

Patient or population: BMI greater than 40 or greater than 35 with comorbidities.
Setting:
Intervention: OAGB
Comparison: RYGB

Outcome № of participants (studies)	Relative effect (95% CI)	Anticipated absolute effects (95% CI)			Certainty	What happens
				Difference		
Quality of life assessed with: Gastrointestinal quality of life index GIQLI follow-up: 1 years № of participants: 145 (2 RCTs)[f]	-	The mean quality of life was **113 to 131**	-	MD **15.03 lower** (45.41 lower to 15.35 higher)	⨁⨁◯◯ Low[b, g]	OAGB may result in little or no difference in QOL compared to RYGB.
Bile reflux № of participants: 322 (3 RCTs)	**RR 17.25** (3.13 to 94.97)	**Study population**			⨁⨁⨁◯ Moderate[b, i]	OAGB likely results in large increase in bile reflux compared to RYGB. [b]
		0.0%	**0.0%** (0 to 0)	**0.0% fewer** (0 fewer to 0 fewer)		
		Moderate				
		0.0%[h]	**0.0%** (0 to 0)	**0.0% fewer** (0 fewer to 0 fewer)		
Malnutrition № of participants: 126 (2 RCTs)	**RR 2.28** (0.13 to 40.45)	**Study population**			⨁◯◯◯ Very low[b, i, j, k]	The evidence is very uncertain about the effects of OAGB compared to RYGB on malnutrition rates after surgery.
		7.4%	**16.9%** (1 to 100)	**9.5% more** (6.4 fewer to 292.2 more)		
		Low				
		0.0%	**0.0%** (0 to 0)	**0.0% fewer** (0 fewer to 0 fewer)		
		High				
		15.0%[a]	**34.2%** (1.9 to 100)	**19.2% more** (13.1 fewer to 591.8 more)		

Summary of findings:

OAGB compared to RYGB for Obesity

Patient or population: BMI greater than 40 or greater than 35 with comorbidities.
Setting:
Intervention: OAGB
Comparison: RYGB

Outcome № of participants (studies)	Relative effect (95% CI)	Anticipated absolute effects (95% CI)			Certainty	What happens
				Difference		
Reoperation № of participants: 388 (3 RCTs)	**RR 1.16** (0.36 to 3.79)	**Study population**			⨁⨁⨁◯ Moderate[l, m, n]	OAGB likely results in little or no difference in reoperation rates compared to RYGB.
		2.1%	**2.4%** (0.8 to 7.9)	**0.3% more** (1.3 fewer to 5.8 more)		
		Low				
		1.0%	**1.2%** (0.4 to 3.8)	**0.2% more** (0.6 fewer to 2.8 more)		
		High				
		3.0%[a]	**3.5%** (1.1 to 11.4)	**0.5% more** (1.9 fewer to 8.4 more)		

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: confidence interval; **MD:** mean difference; **RR:** risk ratio

GRADE Working Group grades of evidence
High certainty: we are very confident that the true effect lies close to that of the estimate of the effect.
Moderate certainty: we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low certainty: our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.
Very low certainty: we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.

Explanations

a. Low and high values are extremes of outcome in control group
b. Downgraded one level for ROB due to no information on blinding of outcome assessors, high and disproportionate missing data and imprecision.
c. Downgraded one level due to high and unclear risk of bias for outcome assessment and high levels of missing outcome data in 4 out of the 5 studies
d. Downgraded another level for selective outcome reporting concerning weight loss in 2 studies
e. Downgraded one level mainly due to high or unclear risk of bias for outcome assessment. Though high risk for missing outcome data, operation time is recorded at the beginning, so we did not downgrade for that
f. upper gastrointestinal symptoms (12 items), lower gastrointestinal symptoms (7 items), physical status (7 items), psychological status (5 items), and social status (5 items). The scores range from 0to 144, with higher scores indicating better function.
g. Opposing effects with one study no difference and the other showing benefit.
h. No events in control arm
i. Though very wide confidence interval we did not downgrade for it because it is due to having no events in control arm
j. Downgraded another level because one other study reported no events and was not included in analysis, but it was up to patients to decide on taking supplements following a protocol and it was unclear how this outcome was measured.
k. Downgraded one level because the studies show opposing results
l. We did not downgrade for the high risk of bias as reoperation is an objective outcome.
m. We did not downgrade even though studies showed opposing results because of very few events in both studies

n. Downgraded one level because outcome CI overlaps line of no effect and fails to determine if OAGB results in benefit or harm

Literature Review

Background

To set the rationale for this review which compares three of the most commonly employed methods of bariatric surgery, the background covers the burden of obesity, describes factors that influence obesity and methods of addressing obesity.

Description of the condition

The World Obesity Federation describes obesity as a chronic, relapsing, progressive disease process that is mainly caused by excessive food intake and low physical activity mixed with environmental factors and genetic susceptibility to obesity (1). The crude measure used to define it is a body mass index (BMI) greater than 30kg/m^2 although different and inconsistent definitions have been used previously (2). Muller argues that BMI does not necessarily correlate well with amount of body fat and the functional impairment caused by excessive fat (3).

Data from 2014 shows that 7 out of 10 women and 4 out of 10 men in South Africa are either overweight or obese respectively(4). The Lancet study, which was conducted by the Institute for Health Metrics and Evaluation at the University of Washington and was a first-of-its-kind analysis of data between 1980 and 2013 from 188 countries In 2016, thirty nine percent of adults were reported to be overweight and 13% of those (650 million) worldwide were obese(5). In the same year 18% (340 million) of children and adolescents aged 5 to 19 years worldwide were reported overweight and obese, an increase from 4% in 1975 (6). In 2019, the number of children under the age of 5 years who were overweight or obese rose to an estimated 38.2 million children (6). Previously it was considered a problem in high income countries. Nevertheless, health care systems in Africa have had to face this new disease burden with prevalence of obesity now higher than global average in northern and southern Africa driven by South Africa (7).

Genetics is a predisposing factor to obesity though it does not account for it in the short term, but rather energy imbalances caused by consuming more calories than those expended. Appetite and satiety is regulated by the hypothalamus as the centre for either orexigenic or anorexigenic stimuli and obesity management strategies target the homeostatic and hedonic regulation of eating(8). Hormones like leptin and insulin decrease appetite by stimulating the melanocortin-producing hormones in the hypothalamus. Amphetamines such as deoxyephedrine and phentermine work by producing catecholamines that stimulate anorexigenic hormones and inhibit the orexigenic neuropeptide Y (9). On the other hand ghrelin, a gastric hormone that peaks prior to eating and decreases post prandial, stimulates appetite by activating neurons that inhibit melanocortin producing hormones (8). Other gut hormones like peptide YY, oxyntomodulin and Glucagon-like peptide (GLP-1) produced by enteroendocrine cells throughout the gut have an appetite suppressing effect. The latter, GLP-1 has incretin effect which enhances glucose dependent insulin release and inhibits glucagon. Its secretion is enhanced post bariatric surgery thus is responsible for the endocrine

changes in hormone secretion post-surgery (9). Beyond this insulinotropic effect GLP-1, acts centrally as an appetite suppressant and delays gastric emptying increasing feelings of satiety (9). Despite most pharmacological targets being located in the brain mostly in hypothalamus, no reliable strategy within the known ways of drug administration specifically targets these sites of action(9). A detailed summary of effect of hormones in obesity is given by Mok et al in his paper whilst Dragano gives an update on drugs used in obesity based on these principles(8) (9).

In addition to environmental, dietary, lifestyle, and genetic influences the gut microbiome (various microorganisms that inhabit the gut) have been found to be host dependent and modifiable by endogenous or exogenous influences to affect predisposition to obesity(10). During early development, the microbiome is affected by antibiotic exposure, breast or formula feeding, pregnancy related conditions and delivery and later on environmental and genetic factors(11). Interestingly transplanting microbiota can predispose obesity resistant germ free mice to become obese and increase energy harvest and calorie uptake (12).

Obesity is associated with sedentary lifestyles, increase in consumption of fast foods and diets rich in fats and sugar. Bleich explores this in his study and concludes that individual country increases in caloric supply over years correlate with the increases in obesity and that calories contribute as much as 93% to change in obesity(13). However in Finland and Australia a decrease in physical activity is responsible for driving obesity(13). In the same study an increase in internet and computer use did not make a significant contribution to increase in obesity in developed countries (13).This is supported in an overview where media and electronic gadgets contributed very little to body fat(14). Urbanization has been associated with increased opportunity to eat, high calorie cheaper foods as well an increase in the number of women working leading to less healthy home cooked food (13). Culture plays a role in how obesity is understood by different individuals either as a disease or as a source of attractiveness (2). Some studies note that South African women do very little exercise and that many, particularly Black women, associate being fat with wealth, health and success, while being thin is associated with being human immunodeficiency virus (HIV) infected. Less commonly, obesity may also be induced by drugs (e.g., high-dose glucocorticoids), neuroendocrine disorders (e.g., Cushing's syndrome), or inherited disorders (e.g., Down's syndrome and Prader-Willi syndrome(15, 16). Obesity is linked with the increase in prevalence and difficulty in controlling chronic conditions like Diabetes mellitus (DM), cardiovascular disease and cancer due to increase in adipose tissue(7).

Interventions to reduce obesity include pharmacological treatment, commercial weight loss programmes and diets, healthy eating, price reductions of healthy foods and tracking systems of food consumption and physical activity (13, 17). For children breastfeeding contributes to a decrease in childhood obesity by 13% (18). An overview including reviews of various interventions noted that numerous guidelines and recommendations have been made to decrease the prevalence of obesity but with very weak evidence(17). In this overview there was no difference in low fat diet vs low carbohydrate diets and diet and physical activity were noted to be more effective than diet alone. Meal replacements and energy restrictive diets had weight reduction ranging from 9.1% to 21.3% depending on extend of energy restriction (14, 17, 19). A recent review looking at low carbohydrate diets in comparison to normal diets found

little or no difference in weight loss or cardiovascular risk factors up to 2 years of follow up in the two groups compared (20).

Addition of medication like orlistat and sibutramine to diet and exercise improve long term weight loss with the latter drug having a weight reduction slightly higher of 4.3kg compared to 2.7 for orlistat after one year (19). Orlistat is a lipase inhibitor that decreases fat absorption through inhibition of pancreatic and gastric lipases(9). Serotonin or hydroxytryptamine agonists like Lorcaserin, a drug approved for long-term treatment of obesity in 2012, act on melanocortin-4 receptors(9). Coagonists and tritagonists targeting GLP-1R, glucose-dependent insulinotropic polypeptide (GIP) and glucose receptors are in development, and these have insulinotropic effects and at the same time reduce food intake, stimulate thermogenesis, and restrain any hyperglycaemic effects of glucagon. Nevertheless, weight loss using pharmacologic methods did not exceed 4kg or 4%. of initial body weight in a review in 2002 (21). Some drugs also have several adverse effects i.e. with orlistat there are reports of serious liver injuries, vitamin deficiencies, diarrhoea, flatulence and abdominal pain (9). Newer strategies using combined therapies like phentermine-topiramate and Naltrexone-bupropion are efficient even as adjuvant therapy post bariatric surgery for sustained weight loss (9, 22) (23)

In adults pharmacological and behavioural interventions have modest outcomes compared to bariatric surgery which has substantial outcomes (17). In severely obese children it has been noted that even if weight loss is achieved through lifestyle modification, the magnitude of the effect is small and severely obese children remain obese (16). Bariatric surgery is typically recommended in morbid obesity, in individuals with BMI >40 , or BMI >35 with serious comorbidities related to obesity(24). In a metanalysis with 11 included studies and 796 individuals, surgery resulted in more loss of body weight, mean difference of –26kg compared to non-surgical interventions(25). Type 2 Diabetes Mellitus (T2DM) remissions were 22 times more likely and metabolic syndrome recoveries 2.4 times more likely after bariatric surgery vs non-surgical treatment (25). Quality of life improvement was consequently better after surgical intervention. However, in patients with class 1 obesity (BMI 30 – 34.99) and T2DM, surgical intervention is less likely to be cost effective (26).

Description of the intervention

One anastomosis gastric bypass (OAGB) is a proposed alternative to Roux n Y gastric bypass (RYGB) and sleeve gastrectomy which are the main operations in many centres.

Table 1 below describes the 3 bariatric surgical techniques to be compared in this review.

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Table 1: *Bariatric surgical techniques to be compared in this review*

Bariatric surgery method	Number of Anastomosis	Description	Reference
One anastomosis gastric bypass	One - Loop gastrojejunal anastomosis at variable lengths distal to the ligament of Treitz.	Long gastric pouch that excludes the fundus and is parallel to lesser curvature. This is then connected to a loop of jejunum.	(27-29)
Roux n Y gastric bypass	Two - Gastrojejunal anastomosis and entero- entero anastomosis.	Small stomach pouch estimated size of an egg and a larger bypassed stomach portion that no longer digests or stores food	(24)
Sleeve gastrectomy	None	Removes 75% to 80% of stomach to leave new 'banana sized stomach'. Attained by stapling over a 40 Fr bougie dilator that is snug against the lesser curvature.	(24) (30)

495 The site of gastroenterostomy in OAGB can be modified distal depending on BMI, height and whether it is a revision case (31) (32).

In an overview, observations from non- randomised controlled studies (RCTs) showed biggest reduction in BMI after RYGB compared with gastric banding and sleeve
500 gastrectomy in paediatrics, with limitations of inappropriate comparison groups , heterogeneity in patient selection, definition of severe obesity and sample size (16). One anastomosis gastric bypass is a restrictive and malabsorptive weight loss surgery and it is thought to be simpler, having a small learning curve and shorter intraoperative time and yet thought to be as effective as RYGB(33). It results in fat and carbohydrate
505 malabsorption and dietary modification (32).

The advantages of OAGB over RYGB is that it can be used as revision surgery for failed gastric bands where the anastomosis is far from the complications caused by the band. In addition it is reversible .and easily revisable by moving the anastomosis
510 (32). Large volume studies from 2001 to 2015 showed 0% mortality and shorter operative times averaging 40 minutes (29).

Why it is important to do this review

Table 2 below shows some systematic reviews in bariatric surgery, all echoing the paucity of RCTs in the field. Since then, more RCTs have been published.

Table 2: *Literature showing available level of evidence in bariatric surgery*

Article /Author	Type of study/ Date of publication	Number of studies included/ publication years	Findings	Authors comments	Gaps noted/ Differences with current review
Efficiency and risk of OAGB (34)	Systematic review /2020.	Number not clear /2005 to 2017 Follow up 12months to 5 years	Estimated weight loss (EWL) after OAGB ranging from 68% to 80% . One study by Lee showed no significant difference between OAGB and other comparative operations. Variable outcomes, in that some studies demonstrated superior weight loss with OAGB, while others reported similar weight loss between OAGB and LSG.	"The limited retrospective data and lack of long-term follow-up longer than 5 years hinders present publications" 'Due to the relative unpopularity of the OAGB, there is a limited amount of level I evidence- based large, controlled trials" The anatomical configuration following surgery, as well as the metabolic implications of its hypo-absorptive nature, raises controversial and ongoing concerns that are yet to be addressed"	-Not clear how many included studies used to draw inferences and if all relevant ones included -No metanalysis
Obesity in children: bariatric surgery (16)	0verview 2015	2 included systematic reviews. January 2010 to August 2014	"We found no direct information from RCTs or systematic reviews comparing different types of bariatric surgery for obesity in children"	"The systematic reviews included mostly non RCTs and studies without appropriate comparison groups and with heterogeneity in the patient selection criteria, definition of severe obesity, and sample size". "Future RCTs should also address questions on effectiveness and safety of the different surgical interventions for obesity in children'	The author team report the most recent, relevant, and comprehensive studies identified through an agreed process involving their evidence team, editorial team, and expert contributors There was paucity of RCTSs as included studies.
One Anastomosis Gastric Bypass in Morbidly Obese Patients with BMI ≥50 kg/m2: a Systematic Review Comparing It with Roux-En-Y Gastric Bypass and Sleeve	Systematic review/ 2019	8 studies between 2008 and 2019	OAGB is safe and effective in super and super-super obese patients and results in similar or higher percentage Excess weight loss (EWL) than with other procedures like SG or RYGB. The mean EWL at 1 year, up to 2 years and 5 years was 67.7%, 71.6% and 90.75%, respectively.	"Size and number of studies limited and mostly retrospective with no RCTs on super obese patients". "Robust studies, ideally in the form of RCTs, with longer follow-up are warranted to allow more accurate comparisons between the surgical options and the impact of pre-operative BMI".	No RCTs at time of analysis for population group -No Metanalysis

Gastrectomy. (35)					
One Anastomosis Gastric Bypass Vs Roux-en-Y Gastric Bypass for Morbid Obesity: An Updated Meta -analysis (36)	Systematic review and metanalysis 2019	16 studies in qualitative analysis 11 in meta-analysis: 3 RCTs, 4 prospective, 4 retrospectives (2001 to March 2019)	The OAGB was associated with greater EWL at 1, 2, and 5 years. Postoperatively OAGB had shorter mean operative time. The length of hospital stay was comparable with that of RYGB. The incidence of leaks, marginal ulcer, dumping, bowel obstruction, revisions, and mortality was similar between the two approaches. However, the OAGB was associated with a significantly higher incidence of malnutrition, thus indicating the significant malabsorptive traits of this operation.	Meta-analysis demonstrates the superiority of OAGB compared with RYGB, in terms of weight loss and diabetes remission. Heterogeneity was high regarding mean operating time (MOT), length of stay (LOS), T2DM, and %EWL at 1 and 5 years postoperatively. Study highlights the need for additional studies comparing the RYGB with the OAGB. Ideally, these would be RCTs, with prospective design and longer follow-up in order to assess the %EWL during greater time-periods.	High heterogeneity for some outcomes with meta-analysis of RCTs, cohort and retrospective studies. More RCTs have been published afterwards and our review will also include comparisons with sleeve gastrectomy.
Surgery for the treatment of obesity in children and of obesity in children and adolescents. (37)	Systematic review 2015	One RCT total 50 participants	At 2 years change in BMI for surgery was 12.7 vs 1.3 for lifestyle intervention.	"This systematic review highlights the lack of RCTs in this field".	The only RCT found was for laparoscopic adjustable gastric banding compared to lifestyle. No RCTS were found to meet objective of assessing effects of surgical interventions for treating obesity in children

Most recently a systematic review (SR) compared OAGB and RYGB in adults and included 3 RCTS, 4 retrospective and 4 prospective studies There was significant heterogeneity in some of the outcomes as the meta-analysis was done on RCTs and non RCTs together(36). By conducting a meta-analysis of randomised controlled trials, we aim to provide an objective summary effect estimate on the selected outcomes and hopefully improve on the hierarchy and quality of evidence. Our review aims to add clarity to the question of whether OAGB is a more efficacious and a safer method compared to RYGB and sleeve gastrectomy by inclusion of only RCTs with the aim of reducing effects of selection bias. The review mentioned above compared OAGB to RYGB, but our review will go further to also compare OAGB to sleeve gastrectomy.

Bariatric procedures are malabsorptive procedures that require long term supplements and sometimes need revision surgery, readmission or reoperation for complications

or recidivism. There is currently no guidance on which method is best suited for low-income countries considering the increase in prevalence of obesity vs issues of low income, the cost of surgery and any workup or follow up needed for possible sequelae like nutritional deficiencies and revision surgeries. These issues are pertinent to clinicians and patients when considering an ideal surgical option. Previous meta-analysis have concentrated on disease outcomes and weight loss without addressing the equally relevant patient important outcomes, quality of life outcomes and cost implications of OAGB. We therefore seek to expand on previous work by clarifying whether OAGB will offer a better value proposition in low-income countries.

Objectives

To evaluate the available evidence from RCTs on efficacy, resource input and safety of OAGB in comparison to sleeve gastrectomy and RYGB in adults and children with BMI above 35, with a view of ascertaining the optimal technique especially in resource constrained environments. The ideal method in this case would be one with the best trade-off between resources used, benefits of getting the procedure and adverse effects.

Research Question

In adults and children with BMI above 35 does OAGB offer better comorbid resolution and quality of life, less adverse events, and better cost implications than RYGB or sleeve gastrectomy?

Methods

Criteria for considering studies for this review

Types of studies

We Included RCTs that included one or more of our outcome measures of clinical efficacy, resource input evaluation and safety. Efficacy was assessed by comorbid resolution and improvement of quality of life. Resource input included resources and time put into doing the procedure. Safety was assessed by looking at adverse effects. The resource input component included studies conducted alongside the main effectiveness trial with estimates of costs and resource input.

Types of participants

Any person regardless of age with morbid obesity (BMI >40), or BMI >35 with serious comorbidities related to obesity.

Intervention

Laparoscopic One anastomosis gastric bypass

Control

Roux n y gastric bypass and/or sleeve gastrectomy. Separate analyses were done comparing OAGB and each of the two comparators.

Types of outcome measures

Primary outcomes

Studies were included if they included one or more of the following outcomes at least 12 months after surgery.

Obesity related comorbidity resolution

(Diabetes, hypertension, hypercholesterolaemia, sleep apnoea, osteoarthritis) assessed by partial or complete remission measured by reversion to normal glucose, BP, cholesterol levels or predefined changes in values, or change in treatment requirements.

Health related quality of life measured using validated instruments

These include Quality-Adjusted Life Years (QALYs) or Disability- Adjusted Life Years (DALY) or any reported patient satisfaction scores immediately post procedure and at least 1 year post procedure

Secondary outcomes

Resource Input

The 3 procedures were assessed looking at the following outcomes

a) Cost of the procedure - direct medical costs i.e., tests and consumables taking note of the price year and currency used.
b) Mean operative time measured in minutes.
c) Mean hospital stay measured in days.
d) Readmission or reoperation rates (reversal or conversions). -measured as serial numbers.

Safety Outcomes: Adverse effects

We used the Clavien-Dindo classification of post-surgical complications in **Table 3** below to index any complications reported in the studies. This is a validated method which eliminates subjective interpretation of serious adverse events and avoids use of terms such as major and minor. It uses data that is well documented and easily verified hence being transparent and avoids tendency to downgrade complications.(38)

Table 3: The Clavien-Dindo Classification

Grade of complication	Definition
Grade I	Any deviation from the normal postoperative course without the need for pharmacological treatment or surgical, endoscopic and radiological interventions. Acceptable therapeutic regimens are: drugs as antiemetics, antipyretics, analgesics, diuretics and electrolytes and physiotherapy. This grade also includes wound infections opened at the bedside
Grade II	Requiring pharmacological treatment with drugs other than such allowed for grade I complications. Blood transfusions and total parenteral nutrition are also included.
Grade III-	Requiring surgical, endoscopic, or radiological intervention
Grade III-a	Intervention not under general anaesthesia.
Grade III-b	Intervention under general anaesthesia.
Grade IV-	Life-threatening complication (including CNS complications) requiring Intermediate care /Intensive care unit management but excluding transient ischaemic attacks.
Grade IV-a	Single organ dysfunction (including dialysis)
Grade IV-b	Multi organ dysfunction
Grade V:	Death of a patient

Comparison of common adverse events were considered individually i.e. anastomotic leaks, malnutrition requiring supplementation, hernias, bowel obstruction, bile leak, recidivism as they contribute to readmission and reoperations or economic burden of these procedures (29, 34). The intention was to choose an ideal method with the best trade-off between resources used, benefits of getting the procedure and adverse effects.

Search methods for Identification of Studies

We identified all potential studies regardless of language or publication status (published, unpublished, in press, and in progress) from Jan 2001 when OAGB was first described to September 2021. We ran two search strategies, the primary strategy identifying studies relating to efficacy (and safety) and the complementary strategy for health economic.

Electronic searches

Primary search

We searched the following databases:

- MEDLINE (PubMed)
- Embase (Ovid)

- Central Register of Controlled Trials (CENTRAL, Cochrane Library)
- Web of Science Core Collection, specifically Science Citation Index Expanded, Social Sciences Citation Index, Conference Proceedings Citation Index (Clarivate)
- CINAHL (EBSCOHost)
- Scopus
- LILACS (Virtual Health Library)
- ClinicalTrials.gov (https://clinicaltrials.gov/ct2/home)
- WHO ICTRP (https://trialsearch.who.int/)

Detailed Medline (PubMed) strategy (adapted to the other databases):

#1 "Bariatric Surgery"[Mesh]

#2 "one anastomosis gastric"[Title/Abstract] OR "one-anastomosis gastric"[Title/Abstract] OR "mini gastric bypass"[Title/Abstract] OR "mini-gastric bypass"[Title/Abstract] OR omega-loop [Title/Abstract] OR "omega loop"[Title/Abstract] OR "single anastomosis gastric"[Title/Abstract] OR "single-anastomosis gastric"[Title/Abstract]

#3 #1 OR #2

#4 obesity [MeSH Terms] or "body mass index" [MeSH Terms]

#5 obese[Title/Abstract] OR obesity[Title/Abstract] OR overweight[Title/Abstract] OR morbidly[Title/Abstract] OR bmi[Title/Abstract] OR "body mass index"[Title/Abstract] OR "body mass"[Title/Abstract] OR "body weight"[Title/Abstract] OR "metabolic disorder"[Title/Abstract] OR "waist hip ratio"[Title/Abstract] OR "waist circumference"[Title/Abstract] OR "abdominal adiposity"[Title/Abstract]

#6 #4 OR #5

#7 randomized controlled trial [pt]
#8 controlled clinical trial [pt]
#9 randomized [tiab]
#10 placebo [tiab]
#11 clinical trials as topic [mesh: noexp]
#12 randomly [tiab]
#13 trial [ti]
#14 #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13
#15 animals [mh] NOT humans [mh]
#16 #14 NOT #15 (39)

#17 #3 AND #6 AND #16

Search	Query
#17	Search: **#3 AND #6 AND #16**
#16	Search: **#14 NOT #15**
#15	Search: **animals [mh] NOT humans [mh]**
#14	Search: **#7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13**
#13	Search: **trial [ti]**
#12	Search: **randomly [tiab]**
#11	Search: **clinical trials as topic [mesh: noexp]**
#10	Search: **placebo [tiab]**
#9	Search: **randomized [tiab]**
#8	Search: **controlled clinical trial [pt]**
#7	Search: **randomized controlled trial [pt]**
#6	Search: **#4 OR #5**
#5	Search: **obese[Title/Abstract] OR obesity[Title/Abstract] OR overweight[Title/Abstract] OR morbidly[Title/Abstract] OR bmi[Title/Abstract] OR "body mass index"[Title/Abstract] OR "body mass"[Title/Abstract] OR "body weight"[Title/Abstract] OR "metabolic disorder"[Title/Abstract] OR "waist hip ratio"[Title/Abstract] OR "waist circumference"[Title/Abstract] OR "abdominal adiposity"[Title/Abstract]**
#4	Search: **obesity [MeSH Terms] or "body mass index" [MeSH Terms]**
#3	Search: **#1 OR #2**
#2	Search: **"one anastomosis gastric"[Title/Abstract] OR "one-anastomosis gastric"[Title/Abstract] OR "mini gastric bypass"[Title/Abstract] OR "mini-gastric bypass"[Title/Abstract] OR omega-loop [Title/Abstract] OR "omega loop"[Title/Abstract] OR "single anastomosis gastric"[Title/Abstract] OR "single-anastomosis gastric"[Title/Abstract]**
#1	Search: **"Bariatric Surgery"[Mesh]**

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Complementary search

Medline (OvidSP)

Embase (OvidSP)

PsychINFO

NHS Economic Evaluation Database (NHS EED)
https://www.crd.york.ac.uk/CRDWeb/

Searching other resources

We searched the proceedings and abstracts of the following bariatric surgery conferences: American College of Metabolic and Bariatric surgery (ACSBS), International Conference on Obesity and Cushing disease (ICPCD), and the International Conference on Neuroendocrinology and Bariatric Surgery (ICNBS). We also hand searched reference lists of included studies and relevant reviews. We contacted experts in the field to find out if they knew of an additional study that we could have missed in our above searches.

Data collection

Selection of studies

Two review authors RK and SN independently screened all abstracts, retrieved by the search strategy above, using predefined eligibility criteria designed and piloted by the review authors. We excluded clearly irrelevant studies. We included reports only published in abstract format to reflect the extent of evidence generated on the subject but not for inclusion in the meta-analysis. We also excluded studies that did not report on the main outcomes but focused solely on adverse events of any of the three procedures. We searched for multiple publications using studies from the same data set and removed duplicate studies. Full-text copies were retrieved for all trials thought to be potentially relevant. These were independently assessed for inclusion in the review using the pre-defined inclusion criteria.

Disagreements in assessment were resolved through discussion. In cases of unresolved differences, a third review author HB adjudicated. The selection process was done in sufficient detail to complete a Prisma flow diagram (see **Figure 1**) and characteristics of excluded studies (see **Table 4**).

Data extraction and management

We designed and piloted data extraction forms (see appendix - **Table 1**). Data extraction and management was done independently and in duplicate. We gathered information from each included trial separately on trial characteristics. These included:

- Study setting, design, study duration, population sample size, and power calculations; geographical setting/country.
- Baseline characteristics of study population including age, sex, BMI, and comorbidities.
- The intervention and control group, type of surgery and indication for surgery.
- Any co-interventions used with control or intervention.
- Timing of outcome measures after surgery.
- Duration of follow-up, any participants who withdrew from the study, and reasons why.

In addition, data collection peculiar to resource input evaluation was also included:

- Cost or resource question addressed by study.
- Measures of resource and time input. Medians were preferred for length of operating time or length of hospital stay due to stability of measures with outliers. However, we extracted whatever measure was reported.

For dichotomous outcomes we tabulated the numbers of participants who developed an outcome or an adverse event (n) with the total sample size number (N) in each of the comparison groups. We documented the different definitions of outcomes in the trials for further consideration and only combine data from endpoints that were similar across studies especially for weight which has many ways of measuring it. For resource cost inputs where possible if a cost -effectiveness analysis included in the study we aimed to extract measures related to resource use and costs. Two review authors RK and HB extracted data in duplicate and resolved discrepancies through discussion with a third review author. Post piloting of the forms we added Gastroesophageal reflux disease (GERD), cholelithiasis and dumping syndrome as adverse effect outcomes to collect.

Assessment of risk of bias in included studies

We assessed the study quality for included RCTs using the latest Cochrane "Risk of bias" (ROB) tool (see appendix – **Table 2**) looking at the following domains:

1. bias arising from the randomization process.
2. bias due to deviations from intended interventions.
3. bias due to missing outcome data.
4. bias in measurement of the outcome; and
5. bias in selection of the reported result.

For each domain an overall risk of bias of 'low risk', 'high risk' or 'some concern' was allocated using signalling questions (40) (41) Using this method the overall risk of bias for the domain was the least favourable assessment across the domains of bias. All studies were assessed for risk of bias independently and in duplicate by RK and HB. We resolved any disagreement through discussion and, where necessary, through consultation with a third review author. Where the proposed domain level or overall, ROB is overridden a justification was given.

The randomization process was assessed by checking if the allocation process was random and concealed. Baseline differences will suggest differences in the randomization process. Blinding of participants, carers and investigators was

considered to assess bias due to deviations from intended interventions. We considered both the intention of blinding and the success of blinding for each outcome and whether the appropriate analysis was used to estimate the effects of the intervention. The effects of not adhering to allocated intervention group was also be considered.

We assessed for missing outcome data in each included trial to determine the proportion of missing results and whether it affected the results or not in terms of event risk and effect size. We considered reasons for missing data and if it were balanced between groups in order to have an overall decision on risk associated with incomplete outcome data.

We examined the objectivity and appropriateness of outcome measures, blinding of outcome assessors and whether some non-protocol interventions i.e., a change in diet or ex were received during the trial that could lead to a bias in estimated effects. We assessed the studies for selective outcome reporting by checking whether outcomes reported were specified *a priori* and whether all timelines mentioned were included.

Other forms of high risk of bias included influence by funders and stopping of the trial before it is finished for unclear reasons were looked at.

If any cost or resource evaluation were included, we assessed the ROB using the CHEC economic evaluation checklist evaluating whether all important and relevant costs had been identified and whether they were valued or measured appropriately.

For adverse events we examined if monitoring was active or passive; whether participants and outcome assessors were blinded; whether the outcome data reporting was complete; whether all participants were included; and whether data analysis was independent of pharmaceutical companies adapted from a study by Bukirwa(42).

Assessment of bias in conducting the systematic review

We conducted the review according to a protocol and reported any deviations from the protocol in the differences between protocol and review.

Data analysis

Measures of treatment effect

We analysed all data using RevMan 5.4. Dichotomous data was pooled using risk ratios (RR) with their corresponding 95% confidence intervals (CI). For continuous data means, standard deviations and sample sizes were used and comparisons were done using mean differences.

Dealing with missing data

We identified studies where missing data affected our ability to measure outcomes and used imputation.

Data synthesis

We used the fixed-effect Mantel-Haenszel model for meta-analysis where there was little heterogeneity and the random effects DerSimonian and Laird inverse variance where there was significant heterogeneity. Studies with no events in both arms for a particular outcome were not included in the meta-analysis. Where meta-analysis cannot be performed, a narrative report was given instead. Cost evaluations often produce heterogenous results because of variable cost of providing care in different countries and settings therefore we did not aim to comment on the overall cost-effectiveness of OAGB vs sleeve gastrectomy and RYGB.

Assessment of heterogeneity

We went through the extracted data from included trials to find key differences in population groups, study setting, intervention and control groups, type of surgery and length of limbs, or timing of outcome assessment. Degree of risk of bias, variation in timing and type of treatment effects was assessed.

We determined the level of heterogeneity by inspecting forest plots for overlapping confidence intervals (CIs). We used a Chi² P value significance level of ≤ 0.1 as likely heterogeneity. The I² statistic was applied according to guidance of: less than 40% as no significant heterogeneity; 30% to 60% representing moderate heterogeneity; 50% to 90% representing substantial heterogeneity; and 75% to 100% considerable heterogeneity.(40). Ultimately a Chi² P value significance level of ≤ 0.1 and an I² statistic value of > 40% was regarded as showing significant heterogeneity.

Subgroup analysis and investigation of heterogeneity

We intended to explore heterogeneity by subgrouping children and adults. If subgroup analysis does not explain the heterogeneity, we also considered a random-effects model, not to perform meta-analysis or use fixed effect meta-analysis with a statistical investigation of the extent of heterogeneity.

Sensitivity analysis

We performed sensitivity analysis for imputed data, high vs low risk of bias or any other peculiarities between the trials identified during the review process.

Differences between protocol and review

We have no analysis comparing complications according to the different classes of Clavien-Dindo as studies reported on individual adverse events and sometimes group

3 and 5. Also clinical significance of specific adverse events is more useful for clinical decision making.

Weight loss data was part of the pilot data extraction form but not a prespecified outcome. We resorted to report on this outcome as it is an important patient outcome and the reciprocal of recidivism.

Reaching conclusions

We based our conclusions on quantitative or narrative synthesis of published included studies in this review. The 'implications for research 'section provides the reader with a clear sense of the remaining uncertainties in the field and the direction of focus required for the future.

Grading of evidence

We used GRADEpro GDT to look at how well the evidence answers our review question. Important outcomes were put in a summary of findings table where the certainty of evidence was graded as high, moderate, low, or very low. We assessed risk of bias, indirectness, inconsistency imprecision and publication bias and accompanied this with explanatory footnotes (40). We assessed how generalisable the findings are to our population.

Results

Results of the search

We identified 7271 records through electronic searches; 1303 from the cost effectiveness search output and 5968 from the safety and efficacy output (see **Figure 1** below for the study flow diagram). 403 duplicate studies were excluded initially then 23 from abstract screening and a further 11 after looking at full texts and identifying studies that were presented at conferences and later published or with similar authors and content. 6784 studies were excluded after reading titles and abstracts leaving 84 for full text assessment. From those, 52 were excluded including a trial that met the inclusion criteria but was later retracted by the authors (**(43)**. The reasons for exclusion are summarised in **Table 4** below. 32 studies in total met the inclusion criteria, 10 published trials, 10 conference abstracts and 12 clinicals trials

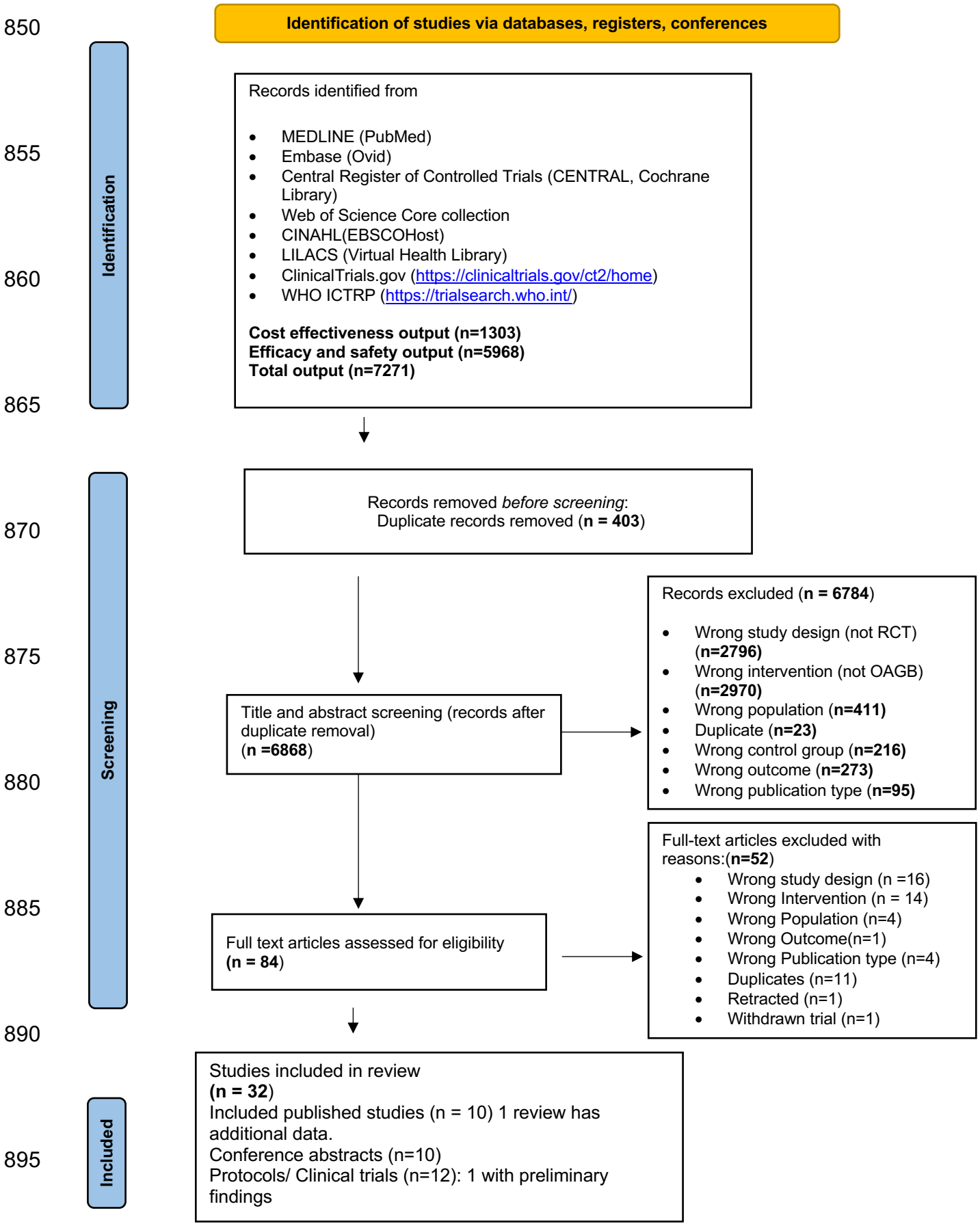

Figure 1: Prisma diagram showing selection of included studies

Table 4: *Characteristics of excluded studies*

Reason for exclusion	Study ID / reference
Wrong study design	Alemrajabi 2019(44)[a], Brosnan 2020(45), Casajoana Badia 2015(46), Chevalier 2015(47), Genua 2020(48), Kansou 2016 (49), Lee 2019(50), Offenbach 2018 (NCT 03526783)(51), Padwal 2009(52) Plamper 2016(53), Pomerantz 2007(54), Rutledge 2009(55), Santos 2013(56), Vilarrasa 2017(57), Ward 2009 (58), Wingfield 2015(59), Wolfe 2005(60).
Wrong Intervention	Barends 2017(61)[a], Benaiges 2020 (62), Bhandari 2020(63), Borisenko 2017(64), Gadiot 2017[a](65), Hofso 2019 (66), Hollanda 2015(67), Katsogianos 2020(68),Lee 2011(69), Lee 2011(69) Melton 2008(70), Salte 2019(71) [a] Schiavon 2018(72), Welbourn 2016(73).
Wrong outcome	Musello[b] 2016(74).
Wrong population	Lee 2011(75), Lee 2011(76), Lee 2014(77), Preset 2019(78).
Wrong Publication	Jones 2005(79), Lass 2018(80), Livingston 2010(81), Maciejewski 2013(82)
Duplication	Elche 2019 (NCT0347646) (83), Krajeveric 2017 [b], Lee 2019(84),
Retracted	Ruiz-Tozar 2018(43) (Ruiz-Tozar 2021(85))

[a] Title includes intervention/ method not reflected in study
[b]Duplicated twice

Included Studies

We included 10 RCTs, 5 comparing OAGB to LSG and 5 comparing OAGB to RYGB.

Characteristics of included studies

OAGB vs LSG

Seetharamaiah 2017, Shivakumar 2018 and Jain 2021 followed the same patient population and reported 1 year, 3 year and 5-year outcomes in the different papers. This Trial was in India, with the largest number of participants of 201. The rest Elsayed 2019 and Roushdy 2021 were in Egypt, both with 1 year follow ups and 25 and 21 participants in each group, respectively. Only Roushdy 2021 reported a sample size calculation. All the trials included adults ranging from 18 to 60 years except Elsayed that did not report their inclusion criteria, but their participants ranged from 20 to 48 years. Mean BMI was 44 .3 to 48 kg/m^2 in the OAGB arms and 44.5 to 51 in the LSG arms. All the surgeons did the LSG using a 36Fr gastric pouch except for Elsayed 2019 that did not describe his surgeries. All trials reported on comorbid resolution, weight loss, mean operative time and adverse events, and none reported on patient satisfaction or cost. **Table 5** summaries the included published studies in this comparison while **Table 3** in the appendix summarises the characteristics and findings of the 5 trials that were identified from conference proceedings.

Table 5: *Characteristics of included studies OAGB vs LSG*

							Outcomes							
Study ID/ Reference	**Country**	**Participants N/**	**Age group range in yrs**	**Follow up yrs**	**OAGB description / mean BMI (kg)**	**LSG description /mean BMI (kg)**	**Comorbid resolution/ Weight loss**	**QOL**	**Patient satisfaction**	**Economic / Cost**	**Mean operation time**	**Mean hospital stay**	**Readmission /reoperation**	**Adverse effects**
Elsayed 2019 (86)	Egypt	25 obese patients in each group	20 to 48	1	NI 47.85 +/- -5.83	NI / 46.68+/-7.8	√√	√	NR	NR	√	√	NR/ √	√
Roushdy 2021 (87)	Egypt	21 morbidly obese in each group	18 to 60	1	38Fr gastric pouch. Gastrojejunostomy 175cm from ligament of Treitz 48.9+/- 6.4	38Fr gastric pouch 51.3+/- 6.5	√√	NR	NR	NR	√	NR	NR/ NR	√
Seetharamaiah 2017 (88)	India	101 OAGB vs 100 LSG morbidly obese	18 to 60	1	Gastrojejunostomy 150-180 cm from ligament of treitz. 44.32+/- 7.88	36Fr gastric pouch. 44.57+/- 7.16	√√	√	NR	NR	√	√	√/ √	√
Shivakumar 2018 (89)	India	101 OAGB and 100 LSG morbidly obese	18 to 60	3	Gastrojejunostomy 150-180 cm from ligament of treitz. 44.32+/- 7.88	36Fr gastric pouch. 44.57+/- 7.16	√√	√	NR	NR	√	√	√/ √	√
Jain 2021 (90)	India	100 OAGB and 100 LSG Morbidly obese	18 to 60	5	Gastrojejunostomy 150-180 cm from ligament of treitz. 44.32+/-7.88	36Fr gastric tube 44.57 +/- 7.16	√√	√	NR	NR	√	√	NR/ √	√

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OAGB vs RYGB

Table 6 below summarizes the 5 Included studies. In addition to Lee 2005 the same author published another article Lee 2019 comparing his results to those of the Yomega trial (Robert 2019) from which extra outcome information was taken(50, 91). 2 studies were done in Egypt and the rest from Taiwan, Venezuela and France. 4 trials had 40 and less participants in each group except for Robert 2019 that had 129 in the OAGB group vs 124 in the RYGB arm. Sample size calculations were reported in Lee 2005, Ibrahim 2021 and Robert 2019. Age range was 18 to 65 years and Level 2005 had the longest follow up of 5 years. The different descriptions for the operations are shown in the table with Ibrahim 2021 standing out with a biliopancreatic limb (BPL) of 150cm meant to explore whether a longer BPL gave similar outcomes to OAGB. Level 2020 had a BPL of 100cm and the rest either 50 or 60cm BPL. The gastrojejunostomy for OAGB was at 200cm in all studies. All studies reported on comorbid resolution and weight loss. Only Fahmy 2018 did not report on operation times and only Ibrahim 2021 did not report on adverse events. None of the studies reported on patient satisfaction or cost. Robert however commented on the number of staples used during the procedure. 9 conference abstracts were identified. We excluded 2 presented by Robert and Ruiz Tozar in 2018 as duplicates as they were later published to leave 7 conference abstracts under this comparis

945 ***Table 6:*** *Characteristics of included studies OAGB vs RYGB*

Study ID/ Reference	Country	Participants N/	Age group range in yrs	Follow up yrs	OAGB description/mean BMI (kg)	Control /description. /Mean BMI (kg/m2)	Comorbid resolution/ Weight loss	QOL	Patient satisfaction	Economic / Cost	Mean operation time	Mean hosp stay	Readmission /reoperation	Adverse effects
Fahmy 2018 (92)	Egypt	30 morbidly obese in each group.[1]	18 to 59	1	Gastric pouch 25-35 ml Gastrojejunostomy 200cm from Treitz 45.5 =/- 5.3	BPL 50cm AL 150cm 44.1=/- 4.7	√√	NR	NR	NR	NR	NR	NR / √	√
Ibrahim 2021 (93)	Egypt	36 morbidly obese in each group	18 to 60	1	Gastric pouch 20-24 cm. Gastrojejunostomy 200cm from Treitz 53.5 +/-- 9.4	36 Fr gastric pouch. 150cm BPL 60cm AL 52.3+/-- 5.1	√√	√	NR	NR	√	NR	NR/NR	NR
Lee 2005 (94)	Taiwan	40 Morbidly obese in each group	18 to 59	2	Gastric pouch 1.5 cm to left of the lesser curvature. (45F) Gastrojejunostomy 200cm from Treitz .44.8 +/- 8.8	15 to 20ml gastric pouch, BPL 50cm 100cm AL for BMI 49 kg/m2 150cm AL for BMI 50kg/m2 43.8+/- 4.8	√√	√	NR	NR	√	√	√/√	√
Level 2020 (95)	Venezuela	33 in ratio 1:2 morbidly obese-9 OAGB and 24 RYGB	>18 years	5	36Fr bougie size gastric pouch Gastrojejunostomy 200cm from Treitz 42.9 +/-5.5	20ml gastric pouch 150 cm alimentary limb 100cm BPL 42.6 +/- 5.9	√√	√	NR	NR[2]	√	√	NR/√	√
Robert 2019 (91)	France	129 OAGB and 124 RYGB morbidly obese	18 to 65	2	37Fr bougie size gastric tube Gastrojejunostomy 200cm from Treitz 43.8+/- 6.1	30ml gastric pouch 50cm BPL 150cm alimentary limb 43.9+/-5.1	√√	√	NR	√ (just as a comment)	√	√	√/√	√

1 - >40 kg/m2 or BMI >35 kg/m2 with comorbidities
BPL- biliopancreatic limb. AL- Alimentary limb.

Characteristics of ongoing studies

Of the 12 ongoing studies shown in **table 7,** three included LSG as a control arm and 9 included RYGB as a control. Saarinen 2019 (96) published 3 month interim data which did not satisfy our review inclusion criteria of at least one year and is still not completed from clinical trials data.

Table 7: *Ongoing studies*

Title /NCT number	Country	Age in years / Population /BMI	Control	Outcomes	Recruitment as per trial registry	Study results	Sponsor	First posted	Start date	Completion date	Last updated
Efficacy and safety of OAGB vs RYGB for type 2 diabetes remission. 0505283	China	18 to 65 / Obese T2DM HBAIC>7/ BMI 27 - 50Kg/m^2	RYGB	DM remission, rate, Change of HbAIC, FBS level, arterial BP, Fasting blood lipids, EWL and total weight loss in 5 years. Incidence of Medical and surgical complications, Postoperative QOL GES reflux, diarrhoea, Dumping syndrome and hypoglycaemia.	Not yet recruiting.	No results posted.	Beijing Friendship Hosp	20-08 -21	1-10-21	31-12 -26	24-08-21
Comparing 150cm OAGB with 150 cm biliopancreatic limb RYGB. A non -inferiority trial (Roux-en WHY?) 04852198	Netherlands	18 to 65 /Morbid obesity[a]	RYGB with a 150cm biliopancreatic limb.	Percentage excess BMI loss after 2 years of follow-up.	Not yet recruiting.	No results posted.	Flevoziekenhuis	6-10-20	14-12-21	14-12-26	15-12-21
RCT Comparing OAGB and Long Limb Roux Gastric Bypass 04812132	Estonia	18-60, Morbid obesity	Long limb RYGB	EWL%, Impact on T2DM, hypertension, hyperlipidaemia, nutritional deficiencies, GERD	Recruiting	No Results posted.	Tartu University Hospital	23-03-2021	01-01-2021	31-12-2031	23-03-2021
The effects of laparoscopic RYGB and laparoscopic MGB on the remission of type 2 DM. 03330756	Netherlands	18 to 65/ Morbid obesity	RYGB	Glycaemic control, insulin sensitivity, Presence of bacterial DNA / bacterial metabolites in portal vein, liver, abdominal adipose tissue, Intestinal and immunological	Recruiting as of November 2017	No results posted	Slotervaart Hospital	06-11-17	23-10-17	01-11-21	09-11-17

				markers, Eating habits.							
Laparoscopic RYGB vs laparoscopic. OAGB 02779322	Spain	18 to 65 / BMI 40 to 50;	RYGB	Hospital cost in Euros, Length of operation in minutes, Weight loss at different time intervals from 3m to 5 years, Abnormal laboratory values or adverse events.	Active not recruiting	No result posted	Puerta de Hierro University Hospital	20-05-16	00-06-15	00-06-25	21-04-20
RYGB vs omega loop gastric bypass (OLGB) Safety and efficacy short term. 002290418	Czech Republic	18-60/ BMI 40-50, or BMI 30 -40 and T2DM or metabolic syndrome	RYGB	Composite measures from bariatric analysis and reporting outcome system (BAROS), Change in %EWL percentage excess BMI, %EBMIL, Change in T2DM, hypertension, dyslipidaemia, proportion of those in partial remission that relapse, change in OSA. Adverse effects - clavien – Dindo, ulcer or abnormal G-scope findings, reoperations. QOL, Length of stay and operative time.	Unknown - Active and recruiting. November 2014	No result posted	Nemocnice B#eclav, p. o	14-11-14	00-01-12	00-12-18	14-11-14
Comparison between the effects of RYGB and OAGB as treatments for morbid obesity prospective RCT. UTN U1111-1203-0901 Rebec (registro Brasileiro DE ensaios Clinicos)	Brazil	18-70, morbid obesity for more than 5 years	RYGB	EWL%, Overall surgical morbidity	Completed recruitment	NI	University Estadual de Campinas	12/20/2017	05/01/2017	NI	NI
Laparoscopic Roux-en-y gastric bypass vs one anastomosis (Mini) gastric bypass. A prospective randomised controlled clinical trial dragons' den meets shark tank proposals for randomized controlled trials.	England	25-60 obese patients. Evenly distributed GORD and HH.	RYGB	EWL% at 2 years, revision surgery for reflux and malnutrition.	NI	NI	Whittington Hospital	NI	NI	NI	NI

Comparison of MGB and RYGB. 02882685	Finland	18 to 65 / BMI >35	RYGB	Weight loss Glucose homeostasis, bile reflux after MGB.	Active not recruiting	Interim results in Saarinen 2019(96)	Helsinki University Central Hospital	30-08-16	00-07-16	00-12-26	13-08-19
SAS-J compared to OAGB and LSG as a treatment for morbid obesity.03821688	Egypt	18-60 / Morbid obesity	LSG and laparoscopic single anastomosis sleeve jejunal bypass.	%EWL, Incidence nutritional deficiency, Rate of improved co-morbidity, Incidence early operative complications.	Completed	No publication linked.	Minia University	30-01-19	15-03-19	10-10-20	11-01-22
RCT on the effect of laparoscopic OAGB vs laparoscopic sleeve gastrectomy in treatment of obese type 2 Diabetic patients. PACTR202010845316667 (ICTRP)	Egypt	>18 T2DM above 30	LSG	HbA1C and FBS	Completed	Results available but no publication linked.	Ain Shams University	202-10-20	01-12-15	03-10-20	29-11-21
Randomized Comparative study of sleeve gastrectomy vs MGB and SASI bypass, Randomised study. 03394157	Egypt	18 to 65 /T2DM Obese patients	SASI (loop rather than Rn Y bipartition reconstruction and sleeve gastrectomy	EWL%, resolution of diabetes -fasting glucose less than 110mg/dl/ HBAIC, 6% without hypoglycaemic medication at 1 year or resolution of at least 25% FBS or 1% in HbA1C.	Completed	No results yet	Tarek Mahdy	09-01-18	00-01-11	02-12-17	02-07-20

Risk of bias of included studies

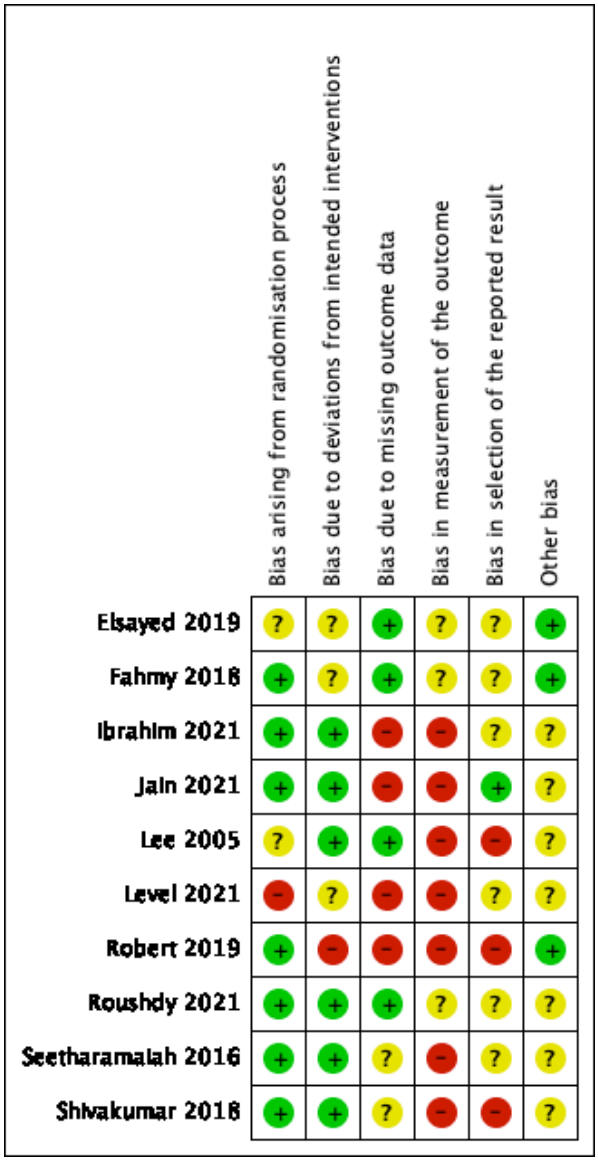

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Figure 2: *Risk of bias summary: review authors' judgements about each risk of bias item for each included study*

OAGB vs LSG

970 **Bias arising from randomization process**

Only 1 trial out of the 5 studies (Elsayed 2019) had some concerns concerning randomization as patients were divided randomly into 2 groups accordance to their admission into study without the method of randomization and concealment being described(86). For Seetharamaiah 2016 and the subsequent reports on the same trial,

Shivakumar 2018 and Jain 2021, computer generated randomization was used using permuted blocks and this was assessed as low risk. Roushdy reported online randomization software with a 1:1 allocation ratio also assessed as low risk. For all the studies there was baseline comparability. Seetharamaiah 2016 and Shivakumar 2018 mention that the groups were similar though the actual significance testing values were reported in the 5-year outcome paper Jain.

Bias due to deviations from intended interventions

All the studies were assessed as low risk under this domain except Elsayed 2019 which had some concerns because he did not provide any information on blinding of participants, clinicians or outcome assessors. Roushdy 2021 was a double-blind study with only the clinicians aware of the allocations. Seetharamaiah 2016 was a single blind study and participants who wanted to make a choice were excluded from the study. We considered that blinding of clinicians is difficult where the interventions are surgical procedures. Appropriate analysis of intention to treat (ITT) and modified intention to treat (MITT) was done in all the studies included under this analysis.

Bias due to missing outcome data

Elsayed 2019 had no loss to follow up while Roushdy 2021 lost one patient in each group. Both were assessed as low risk. The rest of the studies were assessed as high risk due to missing information more than 5% in each group (see

Table 8 below) under missing data for percentages. By 5 years Jain had 27.7% in the OAGB arm vs 29% in LSG.

Bias in measurement of outcome

For QOL and adverse events, the participants are the outcome assessors and 4 of the studies reported blinding of participants. Only Roushdy 2021 reported blinding of outcome assessors. However, it was not clear when gastroesophagoscopy was done in this study to assess for bile reflux and whether it was done to all patients. The definition of weight regain in this study was also not given hence we had some concerns to do with outcome measurement. We had some concerns about Elsayed 2019 who reports on comorbid resolution but does not provide a definition of how it was measured in addition to no information on blinding of assessors. He also used symptomatic reflux to assess for bile reflux where endoscopy which is more objective could have been used. Seetharamaiah 2016 and the follow up reports were assessed as high risk since unblinded clinicians and outcome analysts can influence outcome assessment especially for subjective outcomes and comorbid resolutions where decisions to stop medications are made by clinicians.

Bias in selection of the reported result

Jain defines all outcomes and reports on all timelines and thus was assessed as low risk We had some concerns with Elsayed 2019 as no protocol was published to allow comparison of outcomes. Shivakumar 2018 was assessed as high risk as Jain 2021 reports weight recidivism at 3 years which was not reported in this paper that looked at 3-year outcomes. The same authors report that GERD was almost similar, and no

bile reflux was found in symptomatic patients on endoscopy without actually reporting when the endoscopy was done, and the numbers involved. The same concerns of endoscopy were in Seetharamaiah 2019 and Roushdy 2021. We had some concerns with both.

Other bias

Elsayed had no funding and was assessed as low risk while the rest did not give any information which was of some concern.

OAGB vs RYGB

Bias arising from randomization process

Fahmy 2018, Ibrahim 2021 and Robert 2019 described a randomization method and had baseline comparability. Fahmy used a coin test with no crossover, and the latter 2 computer generated sequence. Robert concealed allocation using sealed envelopes. The 3 were assessed as low risk. We had some concerns with Lee 2005 as he did not report the randomization and allocation concealment methods. Level 2021 randomized 33 patients using a sampling ratio of 1:2 because 96 of his 129 eligible participants refused treatment because they were not familiar with OAGB hence leaving him with smaller numbers to randomize. The method for allocation concealment was not described and we assessed the study as high risk. All studies however had baseline comparability with the only significant difference being more males in Ibrahim 2021.

Bias due to deviations from intended interventions

Robert 2019 was open label and 2 of the 124 assigned to the RYGB had to switch techniques because of technical issues. A per protocol analysis was also done so we assessed his trial as high risk. We had some concerns with the remaining 4 studies. Fahmy 2018, Lee 2005 and Level 2021 who did not report on blinding. Prior to surgery patients in Fahmy were counselled about all possible options but it was not clear whether they were told about the assignments given. Ibrahim 2021 did not blind participants and there was no information on blinding clinicians However for these 4 studies there were no crossovers and appropriate analysis was done.

Bias due to missing outcome data

2 out of 5 studies, Fahmy 2018 and Lee 2005, were assessed as low risk as they had 100% follow up. The remaining 3 were assessed as high risk. Robert had 25% loss to follow up (LTFU) in the OAGB arm compared to 22% in the RYGB arm at 2 years. Ibrahim 16% compared to 2.7% and Level 2021 LTFU of 20.8% limited to the RYGB arm.

Bias in measurement of outcome

4 out of the 5 studies had no information on blinding outcome assessors and whether they were different from the clinicians. Only in Robert 2019 which was open label is it clear that the outcome assessors we not blinded. The difference between partial and

complete comorbid resolutions is whether medication was stopped or not which can be subjective especially in context of unblinded clinicians. We therefore had some concerns with Fahmy 2018 for no information on blinding. The rest were assessed as high risk. In Ibrahim 2021 and Robert 2019 participants were aware of assignment. In addition, in Ibrahim 2021 they also knew the possible side effects and outcomes and in Robert 2019 patients assessed themselves for adverse events and QOL using questionnaires. In Lee 2005 there was no baseline blood sugar, bp or cholesterol levels given, and results were presented as the mean measurements for the groups rather than the change in weight, blood sugar, bp or as partial or complete remission. There was no information on blinding to be able to assess the consequence of this in terms of adverse event and QOL outcomes. Level 2021 gave patients a protocol for them to use to decide on whether to take nutrient supplementation and though authors report no nutritional complications it is not clear what evaluation and tests were done for this outcome. Also, only symptomatic patients with GERD who did not respond to medications underwent endoscopy.

Bias in selection of the reported result

Lee 2005 in his original paper did not report on total weight loss but rather mean BMI in each group but he later reports on this in a later publication Lee 2019. This is despite writing in original publication that they would assess for excess body weight reduction at 1,3, 6, and 12 months postoperatively. Robert 2019 registered his clinical trial NCT 02139813 where absolute weight loss and waist size reduction were outcomes to be assessed at 6 timelines post-surgery, but the outcomes were not reported. The two were therefore assessed as high risk. The remaining 3 studies had no published protocols hence we had some concerns.

Other bias

Fahmy 2018 was assessed as low risk as they reported no funding together with Robert 2019 that was funded by the Ministry of health. We had some concerns with remaining 3. Lee 2005 and Level 2021 had no information and Ibrahim 2021 was funded by the science technology and Innovation funding authority with the Egyptian knowledge bank.

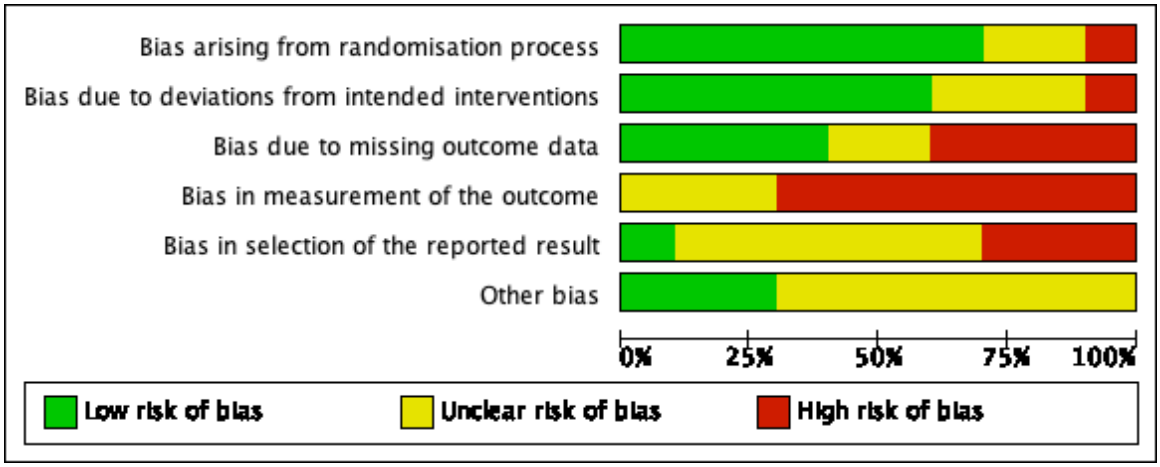

Figure 3: *Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies*

Assessing all the 10 studied the highest risk of bias in 70% of the studies was to do with measuring the outcome. The bias arising from randomization and deviations from intended interventions was mostly low risk in more than half the studies Only 3 trials had 100% follow up, one 4% LTFU and 4 trials above 15% LTFU hence almost equal distribution of low to high risk. Selection bias and other biases related to funding were mainly unclear because of trials not publishing their protocols and not giving information on funding therefore assessed as having some concerns

The parameters assessed for ROB of adverse events are summarised in table 8 below but were also used to inform decisions for the ROB assessments for some of the domains of ROB under efficacy.

Table 8: Summary of ROB Included studies that report adverse events

Study ID	Blinding of participants	Blinding of clinicians	Blinding of analysts	Percentage of missing data	Adverse event monitoring active (yes/ no	Sponsor involvement (yes/no)
Elsayed 2019	NI	NI	NI	0	Yes	No
Fahmy 2018	NI	NI	NI	0	Yes	No
Ibrahim 2021	No	NI	NI	16% in OAGB vs 2.7% in RYGB.	N/A	The Science, Technology & Innovation Funding Authority in cooperation with The Egyptian Knowledge Bank.
Jain 2021	Yes	No	No	27.7% in 0AGB vs 29% in LSG	Yes	NI
Lee 2005	NI	NI	NI	0	Yes	NI
Level 2020	NI	NI	NI	20.8% in RYGB vs 0 in OAGB	Yes	NI
Robert 2019	No	No	No	25% in OAGB and 22% in RYGB at 2 years	Yes	French ministry of health
Roushdy 2021	Yes	No	Yes	4 % in each group	Yes	NI
Seetharamaiah 2017	Yes	No	No	5.6% in OAGB and 6.5% in LSG	Yes	NI
Shivakumar 2018	Yes	No	No	7.9% in OAGB and 8% in LSG	Yes	NI

a - Significance testing only reported in later paper Jain 2021

Data analysis

Primary outcomes:

Comorbid resolution outcomes OAGB vs LSG

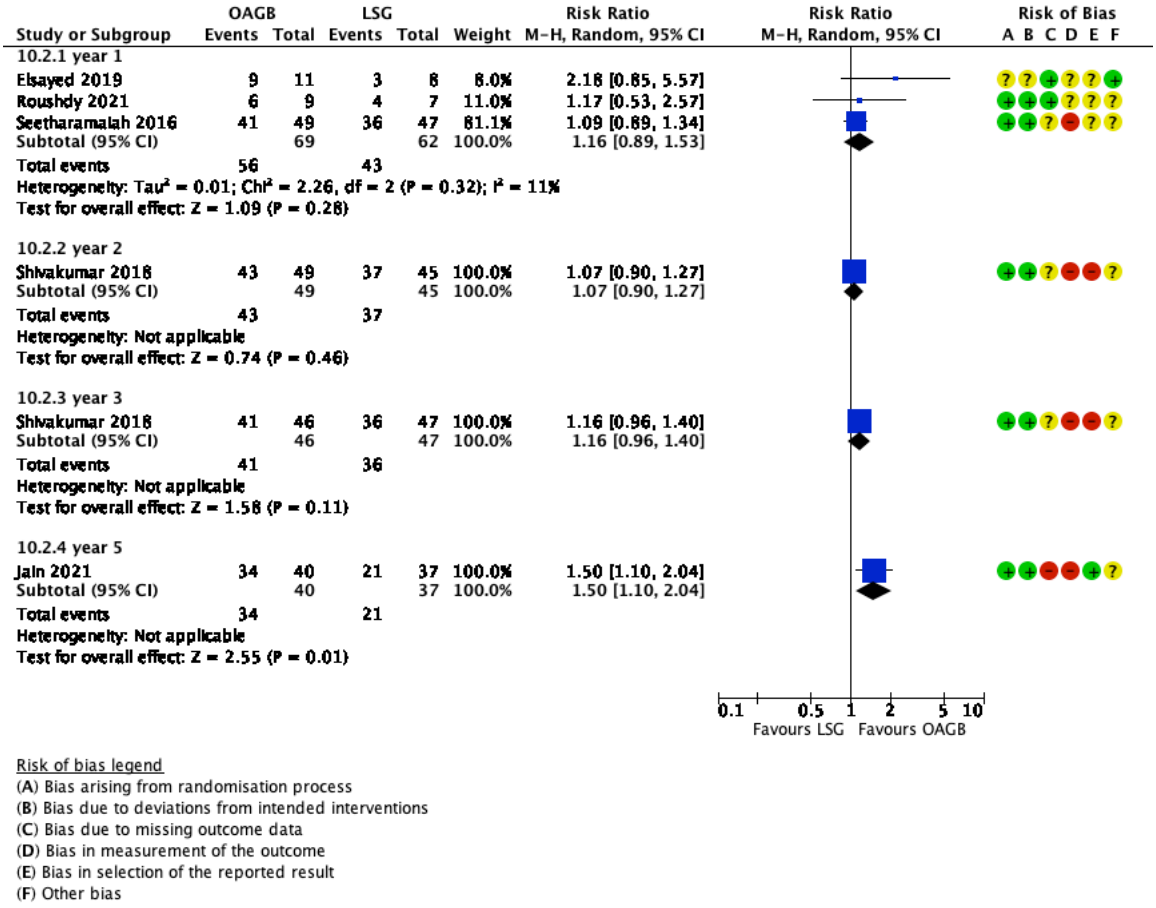

Figure 4: Analysis 1.1 Comparison 1: OAGB vs LSG Outcome 1.1; complete Diabetic resolution

For complete and partial diabetic, hypertensive and cholesterol resolution there was little or no difference at 1, 2 and 3 years between OAGB compared to LSG. At 5 years however data from one study, 85% show complete diabetic resolution in the OAGB vs 56.7% in the LSG RR 1.5 (1.1 to 2.04). Bhandarwar 2017 and Goyal 2020 also reports better metabolic benefits in then OAGB from 4th year onwards in his conference abstract.

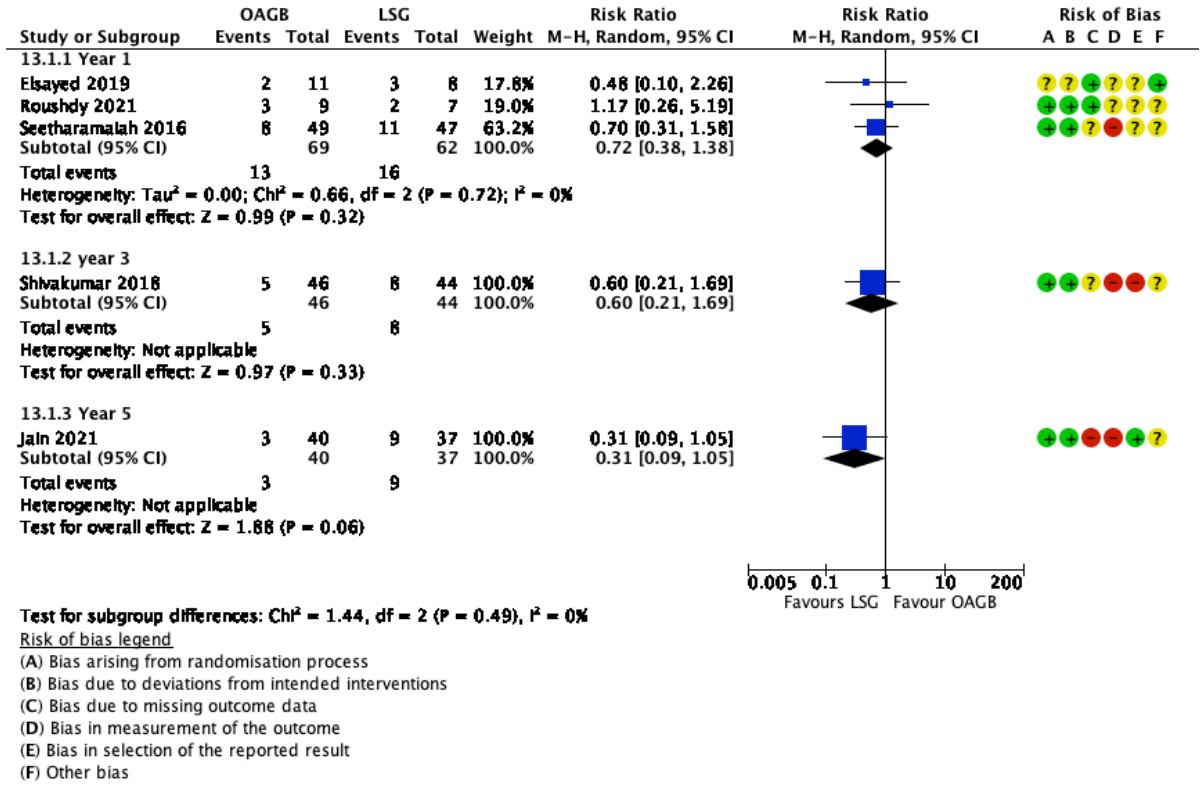

Figure 5: Analysis 1.1 Comparison 1: OAGB vs LSG Analysis 1.2: Partial DM resolution

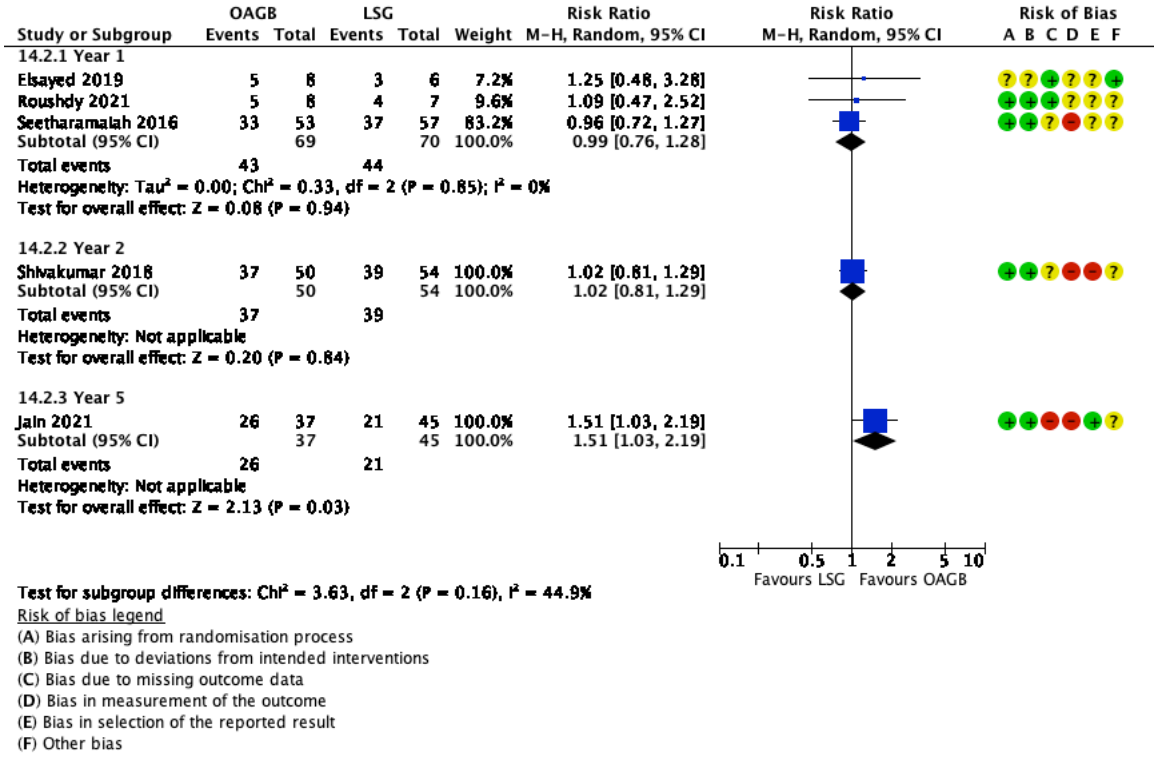

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Figure 6: *Analysis 1.1 Comparison 1 OAGB vs LSG: Outcome 1.3: Complete hypertension resolution*

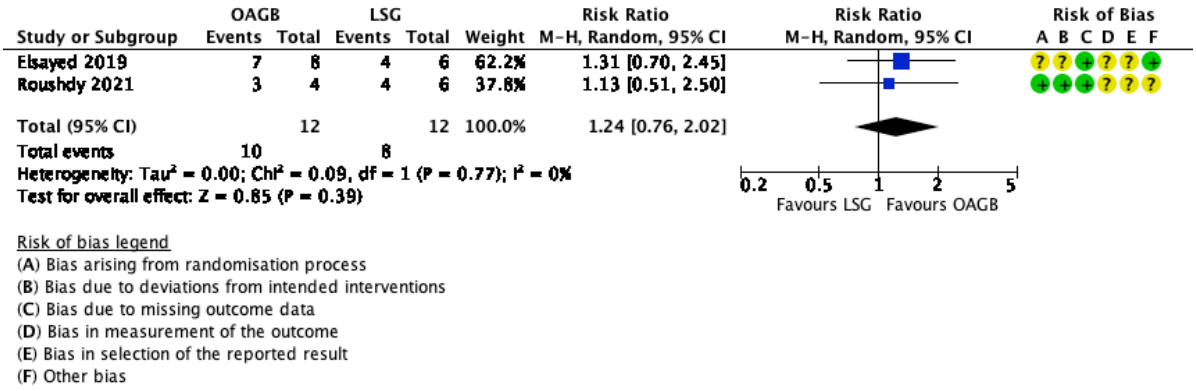

Figure 7: *Analysis 1.1 Comparison 1: Outcome 1.4; Complete Cholesterol resolution*

For hypertension complete resolution, BP <140/90 without medicines, there is little or no difference at all time periods though at 5 years OAGB results in likely more hypertension resolution, RR 1.51(1.03,2.19). Elsayed 2019 report cholesterol resolution in 1 out of 8 compared to 2 out of 6 in the LSG arm. In the same study, everyone with osteoarthritis and obstructive sleep apnea in both groups had complete resolution. In Roushdy 2021 there was no significant difference in resolution of pulmonary obstructive airways disease.

Similar to hypertension resolution, there is no little or no difference in remission of OSA (75% in OAGB vs 63.6% in LSG) and osteoarthritis /DJD (63% in OAGB and 52.9% in LSG) at 5 years(90). Prior to that the papers reporting the 1-to-3-year outcomes do not report on OSA and osteoarthritis).

The comorbid scores are not significantly different at 2 and 3 years in Shivakumar 2018. At 5 years, Jain reports a significantly higher score of 2.24 in OAGB compared to 1.84 in LSG as well as the BAROS score with comorbidity included.

4 out of the 5 conference abstracts report on DM resolution and all of them in contrast to published results and meta-analysis report better comorbid resolution from OAGB compared to LSG.

Comorbid resolution OAGB vs RYGB

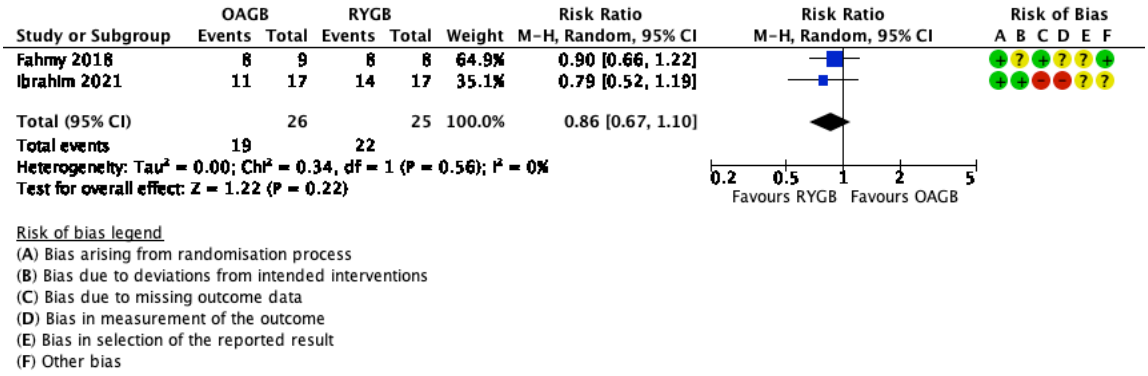

Figure 8: *Analysis 1.1 Comparison 2: OAGB vs RYGB, Outcome 1.1: DM resolution at 1 year*

From 2 studies and 51 participants, there is little or no difference between OAGB and RYGB in terms of complete diabetic resolution at 1 year RR 0.86 (0,67 1.10. The same findings are reported in the included conference abstracts (see appendix - **Table 4**).

Two-year outcomes

Robert reports no significant difference in the DM remission rate, 60% in the OAGB arm compared to 38% in the RYGB arm at 2 years post procedure. Lee on the other hand has significantly more DM resolution post OAGB at 2 years of 81.9% compared to 55% post RYGB. Meta-analysis could not be done as total numbers of diabetics in the two groups were not reported at baseline but instead the percentages of those who had metabolic syndrome. 5-year outcomes were reported in a study by Level 2021 where the 1 diabetic in the OAGB arm and the 2 in the RYGB had complete remission by 5 years.

From 2 trials with 28 hypertensive patients at baseline there was no difference in complete hypertension resolution.

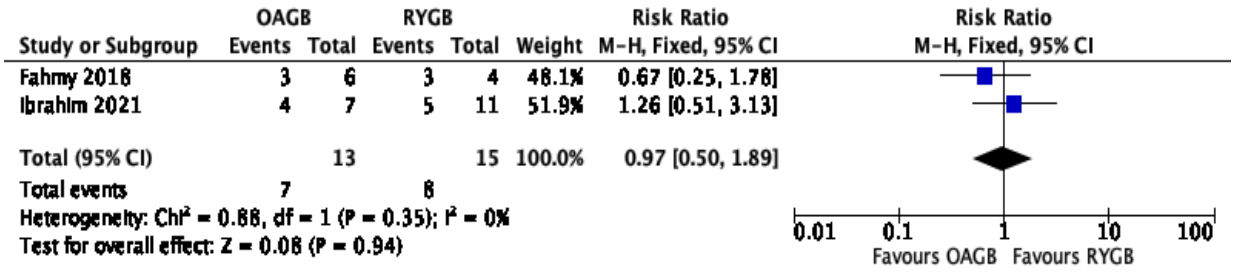

Figure 9: *Analysis 1.1 Comparison 2: Outcome 1.2: Complete hypertension resolution*

At 2 years Robert has no hypertension resolution data. Lee reports on the mean systolic and diastolic bps in both groups which were not significantly different There is

no data on the baseline mean blood pressures or percentages of hypertensive patients in the 2 arms to be able to comment on resolution.

At 5 years 2 out of 4 hypertensives had complete remission in the OAGB arm compared to 4 out of 6 in the RYGB. 2 had partial remission in the OAGB arm compared to 1 with partial remission and one with no change in the OAGB arm. The overall resolution of comorbidities was not statistically different 77% in OAGB vs 89% in RYGB(95).

Outcome 1.3: Complete Cholesterol resolution

All participants in the Level trial had resolution of dyslipidemia to total cholesterols lower than 200mg/dl. There was no significant difference in Roberts 2019 between OAGB and RYGB at 2 years for decrease in total cholesterol, triglycerides and low-density lipoproteins as well as increase in high density lipoprotein.

Outcome 1.4: Osteoarthritis

Ibrahim showed no significant difference (p = 0.922) in joint and backpain, 56.3 % had resolution in the OAGB group vs 57.9% in the RYGB group.
Robert reports 100% resolution of metabolic syndrome in OAGB. and RYGB groups. Fahmy, Lee and Level and Robert do not look at remission of osteoarthritis or obstructive sleep apnea. 3 Conference abstracts, Bhandarwar 2017, Elkeleny 2017 and Singh 2019 echo no difference between the two operation techniques in terms of comorbid resolution.

Outcome Weight loss

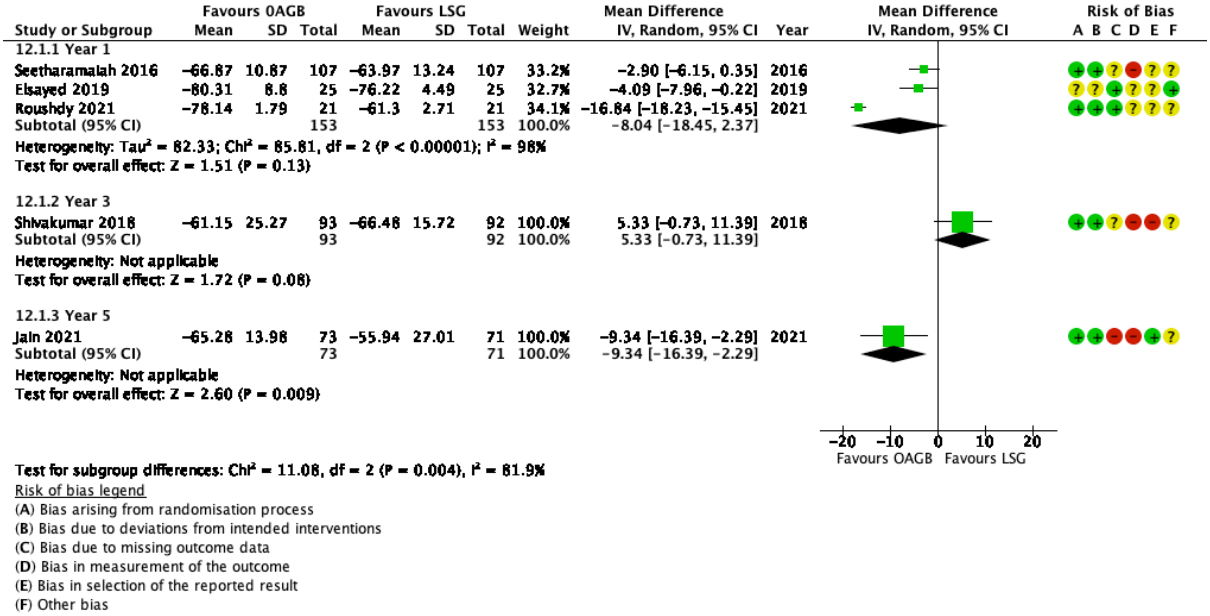

Figure 10: *Analysis 1.2 Comparison 1; OAGB vs LSG Outcome: Weight loss*

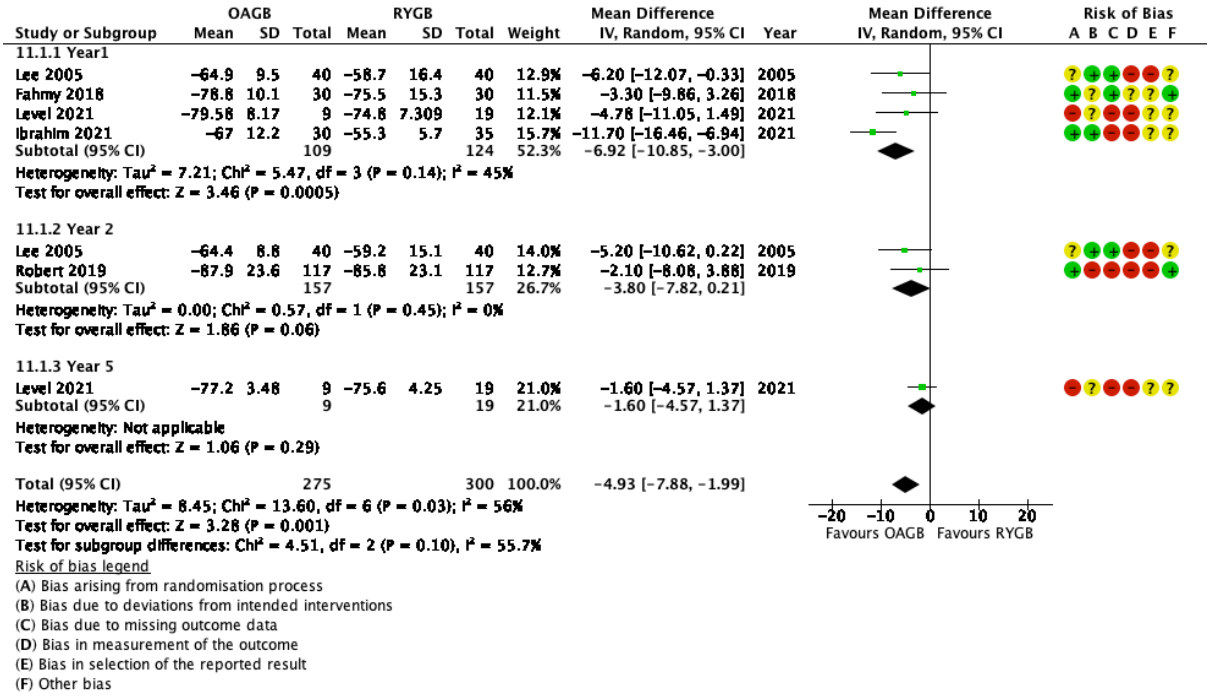

Figure 11: *Analysis 1.2 Comparison 1; OAGB vs RYGB Outcome: Weight loss*

Compared to LSG at 1 and 3 years there is no difference in EWL% but at 5 years OAGB results in larger weight loss of 65.28% compared to 55.94% in the LSG group RR -9.34 (-16.39, -2.29). Conversely, at one year. OAGB may result in a larger EWL% loss of -6.92% compared to RYGB. This larger EWL% is similarly reported in the conference abstracts (see appendix - **Table 4**). By 2 years and 5 years there is little or no difference even when you remove the data from Robert 2019 which is a high-risk trial in many domains. At 5 years in Level 2021 the EWL% was not much different from that at one year. Cumulatively OAGB may result slightly better EWL% -4.93 (-7.88, -1.99) compared to RYGB.

Quality of Life and Patient Satisfaction

Analysis 1.3: Comparison 1; OAGB vs LSG, Outcome; Quality of life and Patient satisfaction

Elsayed 2019 did not have a specific QOL outcome, but they report no significant difference in return to work which was 13 days in the OAGB group vs 11 days in the LSG group. The LSG group took 4 days to return to daily activities which was significantly different to the 5.8 days in the OAGB.

After 1 year through to 3 years there was a better BAROS score with comorbidity in the OAGB as shown in table 9. The BAROS scoring system is based on total scores in %EWL, QOL assessment with or without comorbid resolution. Without comorbidity there was no significant difference up to 3 years.

Jain reports 4- and 5-year outcomes. This time at 5 years with or without comorbidity resolution the total BAROS score was higher in the OAGB group compared to LSG.

OAGB gave a significantly better QOL score (self -esteem, physical, social, labour and sexual components at 5 years of 2.35 compared to 1.86.

Table 9: *Summary of QOL scores per year OAGB vs LSG*

Study ID	Follow up	BAROS with comorbidity /significance	BAROS without comorbidity /significance	Comment
Seetharamaiah 2016	1	6.09 vs 5.37 P<0.0001	3.96vs 3.71 NS	Significantly better QOL after OAGB compared to LSG in those with comorbidity
Shivakumar 2018	2	6.96 vs 6.15 P=0.0018	4.34 vs 3.95 P=0.385	
	3	6.96 vs 6.03 P=0.0066	4.37 vs 3.86 P=0.320	
Jain 2021	5	6.84vs 5.34 P=0.0001	4.28vs 3.41 P=0.0079	Significantly better QOL after OAGB compared to LSG with/ without comorbidity

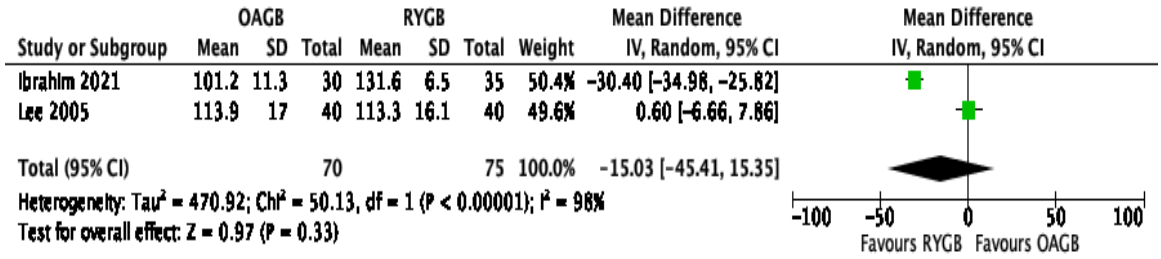

Figure 12: *Analysis 1.4 Comparison 2; OAGB vs RYGB, Outcome 3; Quality of life summary and Patient satisfaction*

Ibrahim 2021 reports a significantly better QOL postoperatively in the LRYGB arm at 3, 6 and 12 months using the gastrointestinal quality of life index (GIGLI). This score has 4 domains assessing QOL in patients with gastrointestinal disease including gastrointestinal symptoms, physical function, social functions and emotional functions(97). At 12 months the score was 131 in the LRYGB arm compared to 101.2 in the OAGB arm. Lee 2005 uses the same score and has similar scores of 113 in both groups with no differences in the baseline preoperative scores. Overall using this GIQLI there is no difference.

Roberts had 63 /67 (94%) people in the good, very good and excellent QOL BAROS score compared to 54 / 63 (86%) in the RYGB. This was not significantly different P value 0.15 at 2 years. Self-esteem scores are part of the QOL domain of the BAROS score but can be used a s a proxy of patient satisfaction. Self-esteem improved by a score of 11.2 in those who had OAGB vs 12.1 in those who had RYGB in this study which was not significantly different

Secondary Outcomes

Resource Input Cost

There was no cost of procedure data in all studies, but Level 2021 reports a significantly larger number of staples median 6 to 8 for RYGB procedure vs 4 to 6 reloads for OAGB; P value 0.0002

Operation time

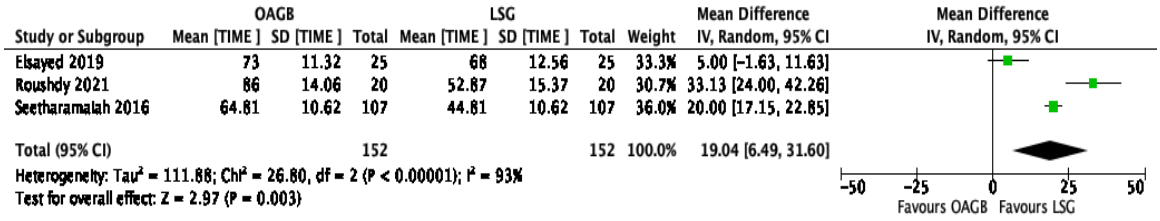

Figure 13: *Analysis 1.5 Comparison 1: OAGB vs LSG, Outcome 1.1: Operation time.*

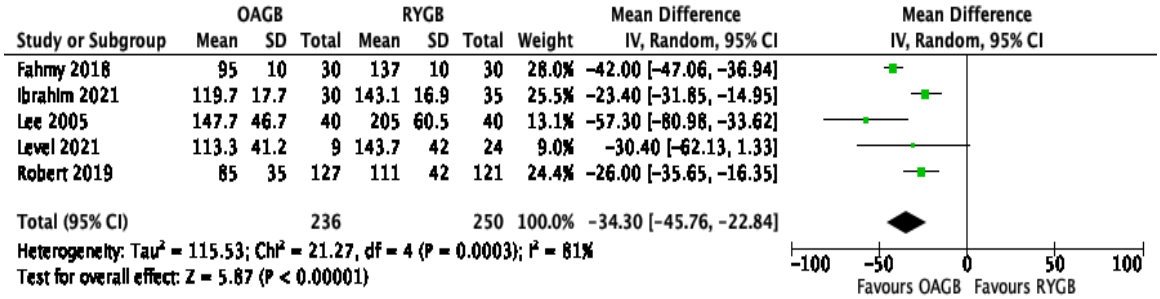

Figure 14*: Analysis 1.5 Comparison 2: OAGB vs RYGB Outcome 1.1: Operation time.*

From this analysis LSG takes the shortest time followed by OAGB and the RYGB. RYGB takes between 22 to 45 minutes longer while LSG is between 6 and 31 minutes shorter.

Length of Hospital stay

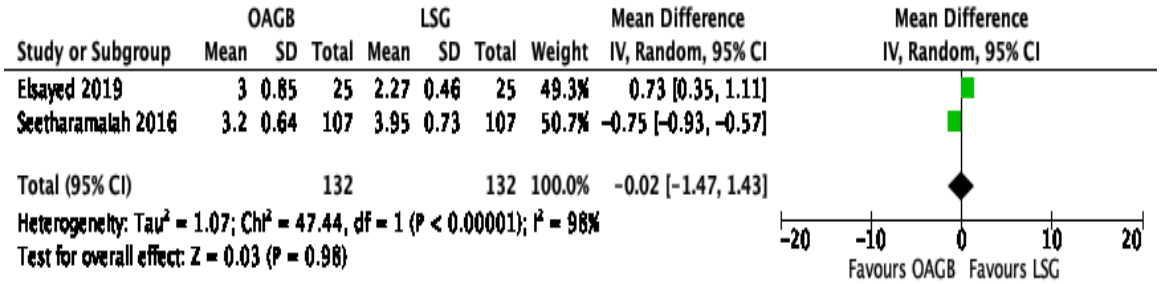

Figure 15: *Comparison 1: OAGB vs LSG, Outcome 1.2: Length of hospital stay*

There is no difference in length of hospital stay after OAGB vs LSG.

Comparison 2: OAGB vs RYGB Outcome1.2: Length of hospital stay.

Only one study by Lee reports a significantly shorter length of hospital stay (5.5, days SD 1.4 in the OAGB arm compared to 6.9 days with SD 2.8; P value <0.001). Fahmy 2018 reports a standard hospital stay of 2 days if patient was able to go home after removal of drain. However, they do not report on a mean or median length of stay in the two groups. Ibrahim 2021 does not report on data on this outcome. Robert 2019 shows a median range of 5 days in each group with a range of 4 to 5 days in the OAGB arm vs 4-6 days in the RYGB arm. Level 2021 reports a 3 day stay for all patients except 1 from each group due to abdominal distension and ileus.

Reoperation

Elsayed 2019 reports 1 reoperation in LSG arm due to bleeding. At 1 year in Seetharamaiah 2016 there was one reoperation due to a bleeding marginal ulcer in a smoker in the OAGB and 1 in LSG who needed laparoscopy for a leak. At 2 years in the same trial 1 patient had reoperation to revise LSG to OAGB due to inadequate weight loss and diabetic remission (89).

At 5 years as reported by Jain 2021, 3 patients had laparoscopic cholecystectomy for cholelithiasis in the OAGB compared to 1 in LSG. There were also 2 hernia site repairs in the LSG group. Overall, OAGB may result in little or no difference in reoperation rates compared to LSG RR 0.70 (0.23, 2.18).

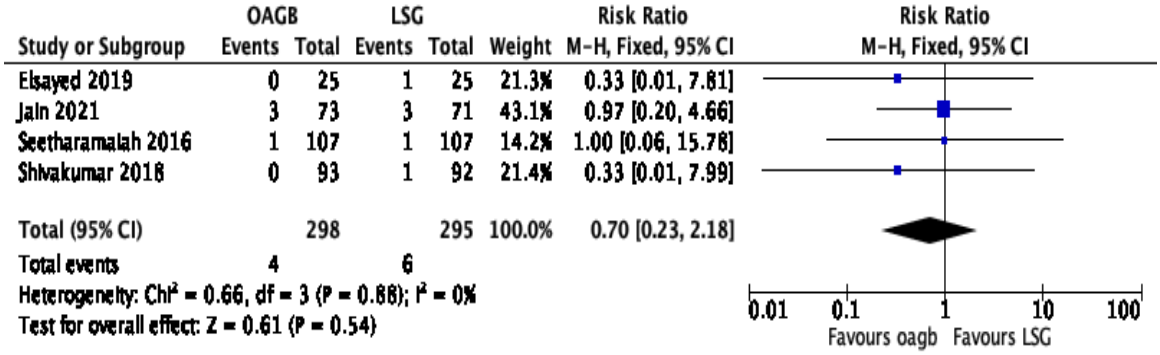

Figure 16: Comparison 1: OAGB vs LSG, Outcome 1.3: Reoperation

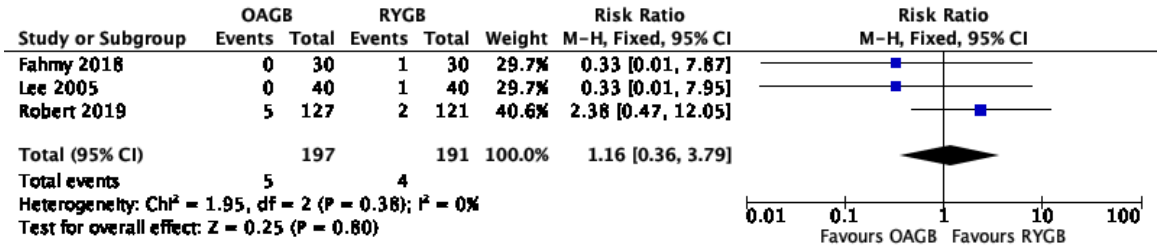

Figure 17: *Comparison 2: OAGB vs RYGB, Outcome 1.3 Reoperation*

Fahmy 2018 reported 1 port site hernia repair in the RYGB arm. In Robert 2019 four (3%) of 127 patients with OAGB who underwent assigned surgery required conversion to RYGB: one for an anastomotic leak, one for Wernicke encephalopathy, and two because of severe biliary reflux not responding to medical therapy and then an additional one due to peritonitis. In the RYGB there were however no conversions. 2 patients required reoperation for bowel obstruction and hemoperitoneum. The one reoperation in Lee in the RYGB group was due to an anastomotic leak. Level 2021 had a five year follow up with no reoperation. Overall, the pooled data of the 3 studies, 388 participants with no significant heterogeneity showed no difference in reoperation rates between the two surgeries.

Readmissions

Outcome 1.4; Readmissions

OAGB had 10 readmissions compared to 12 in the LSG arm elaborated below.

Table 10: Causes of readmissions OAGB vs LSG

Reason for readmission	OAGB	LSG
Wound infections	4	6
Nausea and vomiting	3	4
Bleeding	1	1
Marginal ulcer	1 bleed and 1 perforation	-
Anastomotic leak		1

For the RYGB comparison Robert reports 5 out of 24 patients readmitted post RYGB due to abdominal pain in comparison to no admission in the OAGB arm. Lee reported 3 readmissions in each group.

Adverse events

Ibrahim 2021 has no adverse event data.

Outcome 1.5: Anastomotic leaks

Compared to RYGB, OAGB results in little to no difference in anastomotic leaks RR 0.65 (0.11, 3.90) from 2 studies. Lee reported 2 out of 40 in the RYGB and Roberts 1 out of 127 in the OAGB. In the comparison against LSG, Seetharamaiah had 1 leak out of 107 patients in LSG group.

Outcome1.6: Bowel obstruction

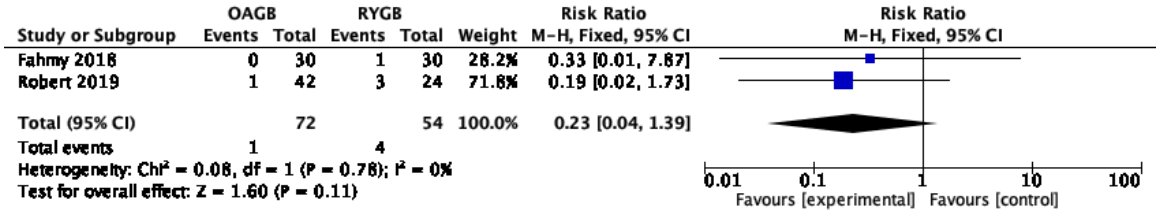

***Figure 18**: Comparison 1 OAGB vs RYGB Outcome 1.6: Bowel obstruction*

None of the patients got bowel obstruction in the studies comparing OAGB to LSG. Only 4 patients in the RYGB arm complicated with bowel obstruction. The 1 reported in Fahmy 2018 was secondary to a stricture that had to be balloon dilated post RYGB. Though Robert reports 3 patients in RYGB in a table, he only reports one in the text. Overall, there was no difference regardless which figures were used in the meta-analysis. Lee and Level report one patient in each group complicating with ileus.

Outcome1.7: GERD and Bile reflux

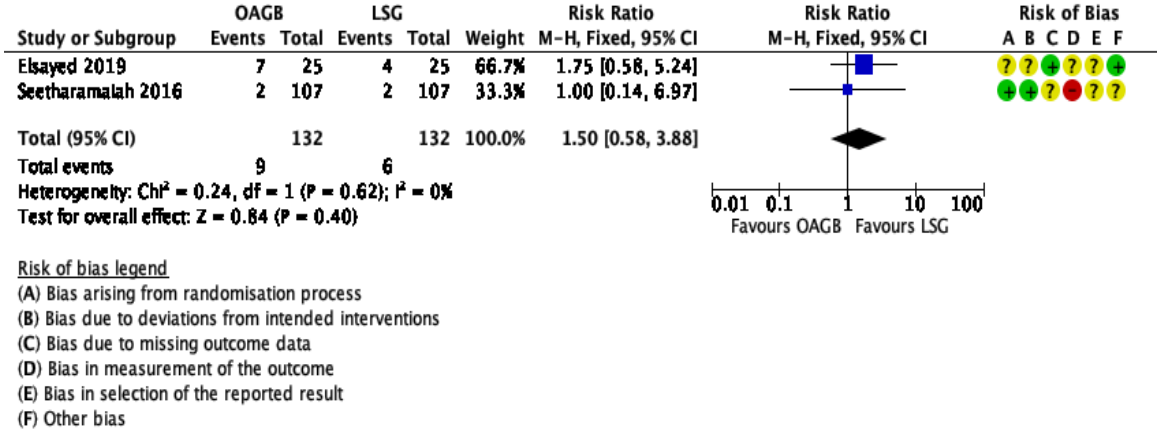

***Figure 19:** Comparison 1: OAGB vs LSG, Outcome 1.7: GERD and Bile reflux*

GERD symptoms were reported in 2 patients in the OAGB compared to 3 in Seetharamaiah 2016 and Shivakumar 2018. By 5 years follow up it was 3 in OAGB compared to 4 in LSG. Seetharamaiah and Shivakumar et al did not find significant incidence of biliary reflux in OAGB patients when they performed endoscopy on symptomatic patients. The authors attributed this to a long gastric tube with a dependent gastrojejunostomy. They did not perform postoperative pH studies in their trial Roushdy 2021 reports 3 people in OAGB as having dyspepsia.

From 2 studies with 264 participants, one is 1.5 times more likely to get biliary reflux after having a OAGB in comparison to LSG, (p = 0.40).

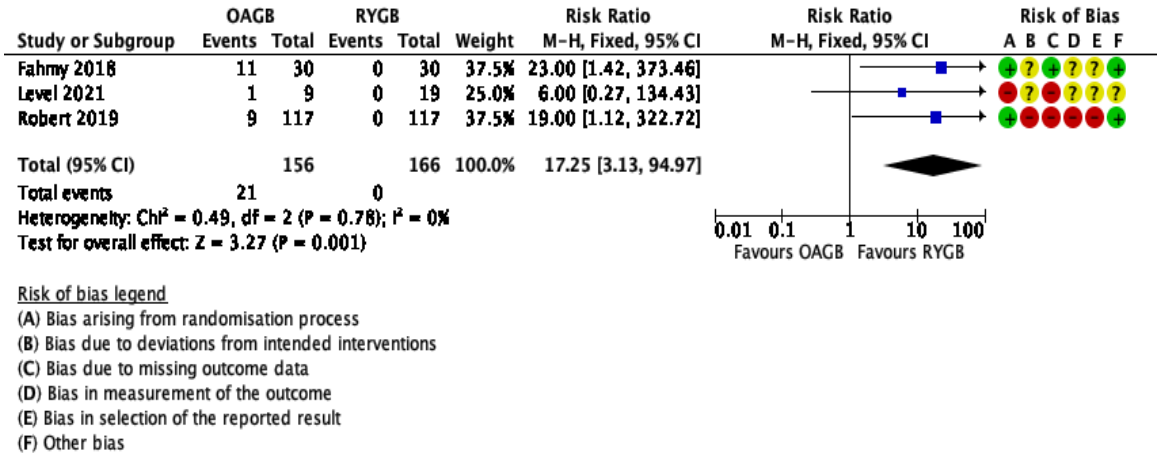

Figure 20: *Comparison 2: OAGB vs RYGB, Outcome 1.7 GERD and Bile reflux*

Fahmy 2018 reported 11 had bile reflux confirmed endoscopically in the OAGB arm compared to none in the RYGB group. In Robert 2019 four patients in the OAGB arm compared to 1 in the RYGB arm reported GERD symptoms and this was not significantly different. In contrast on endoscopy 9 (16%) had evidence of biliary reflux in the OAGB arm compared to none in the RYGB. 2 of these patients had to be converted to RYGB due to failed medical therapy. 1 patient in the OAGB had intestinal metaplasia on biopsies taken. Lee 2005 reported no significant difference in GERD symptoms. Level 2021 reported 1 patient with GERD confirmed as reflux on endoscopy in OAGB arm. A pooled total of 21 out of 156 patients had biliary reflux confirmed endoscopically in the OAGB arm compared to none in the RYGB arm RR 17.25 (3.13, 94.97).

Outcome 1.8: Marginal ulcers

Seetharamaiah 2016 reports 2 in OAGB of which one perforated 11 months post-surgery requiring an omental patch repair. By 5 years 5 patients in OAGB had marginal ulcers managed with PP1 compared to none in the LSG. arm.
The incidence of marginal ulcer was 5% in the OAGB arm compared to 3 % in the RYGB arm also managed by PPI (Lee 2005).

Outcome 1.9: Malnutrition

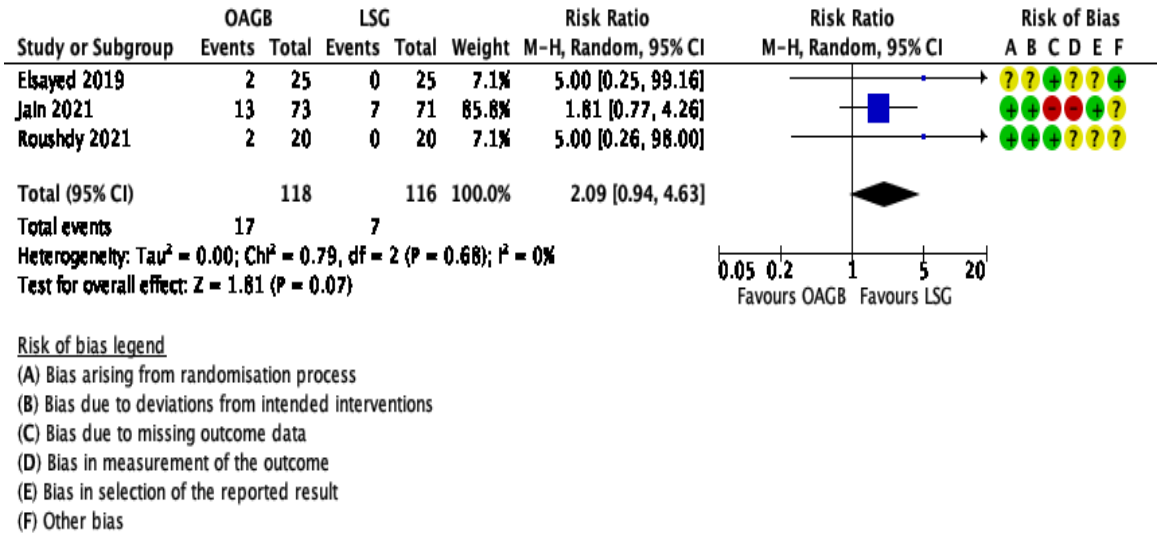

***Figure 21**: Comparison 1; Outcome 1.9 OAGB vs LSG: Malnutrition*

There is little or no difference in malnutrition requiring supplements between those who get a OAGB compared to sleeve gastrectomy though evidently far more people got malnourished after OAGB vs LSG RR 2.09 (0.94, 4.63)

No severe malnutrition was reported after 5 years (Jain 2021. However, 6 patients required protein supplements for hypoalbuminaemia and 7 for anaemia in the OAGB group compared to 3 and 4 respectively in LSG group. After removing Jain 2021 which is high risk on outcome assessment and yet is the largest contributor to the analysis there is still no difference in malnutrition rates.

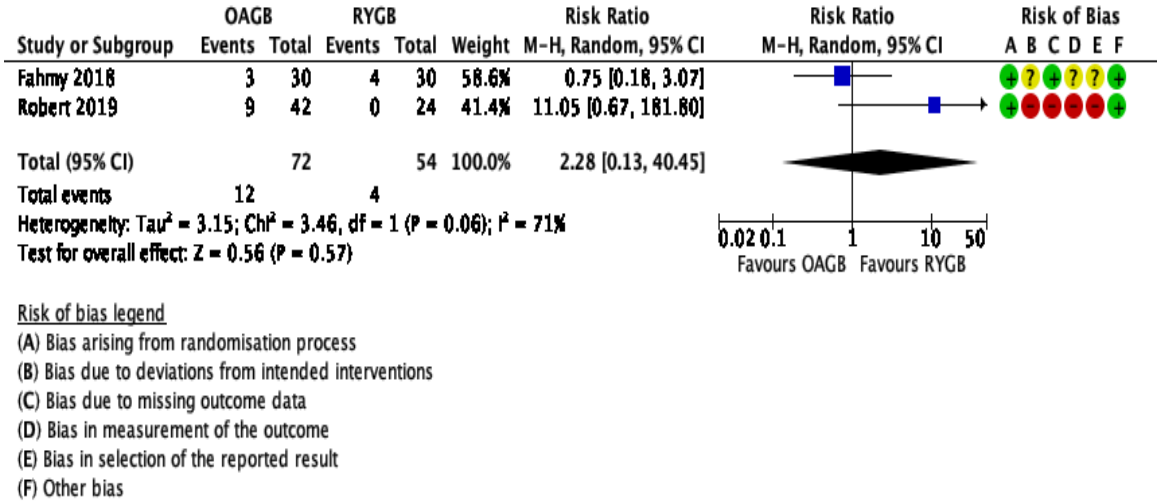

***Figure 22:** Comparison 1; Outcome 1.9 OAGB vs RYGB: Malnutrition*

There was also no difference between OAGB and RYGB. The 2 studies show results in different direction with marked heterogeneity. Though Robert 2019 is a high-risk study removing it would still result in an outcome of no difference. There are no events in the LSG arm thus there is a large confidence interval.

Outcome 2.0 Hernia

There was no difference in hernias, 1 each in the comparison between OAGB and RYGB. A total of 6 out of 96 in LSG vs 2 out of 98 in OAGB had hernias.

Outcome 2.1: Cholelithiasis

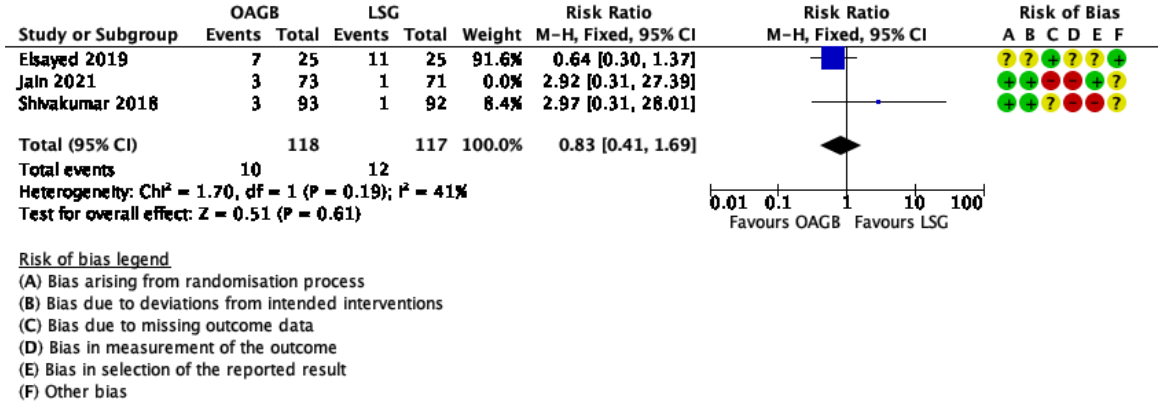

Figure 23: *Comparison 1: Outcome 2.1 OAGB vs LSG: Cholelithiasis*

No difference in rates of cholelithiasis between OAGB and LSG in the 3 studies that reported this. Shivakumar reports 3 vs 1 (p=0.6212), all requiring laparoscopic cholecystectomy. The authors comment that the incidence is higher in the OAGB arm, and they attribute it to alterations in bile salts and absorption and enterohepatic circulations. Elsayed had 7 out of 25 patients with symptomatic cholelithiasis in the OAGB group and 1 needed surgery vs 11 out of 25 in the LSG arm 3 requiring surgery

Outcome 2.2: Recidivism

Recidivism was only reported in 3 patients from 2 studies in those who got LSG, one of them requiring a revision to OAGB at 2 years. (Roushdy and Shivakumar**).**

Outcome 2.3: Mortality

Only one study reported non surgery related mortality: 1 in OAGB due to unknown cause and 1 due to acute MI after 1 year in LSG. (Shivakumar). There was no known mortality between 3 and 5 years. No mortality is also reported in the comparison against RYGB. Roberts and Ibrahim do not give information on mortality.

Subgroup analysis

We were unable to perform our planned subgroup analysis for adults and children because there were no RCTs on children. Our data was presented for different years for outcomes like comorbid resolution and weight loss where follow up was for different durations to illustrate the time-based differences.

Sensitivity analysis

We performed the following sensitivity analysis.

Changing from fixed- effect and random-effects models.

Excluding and including high risk trials to a metanalysis involving many studies.
None of the results conclusions were affected by this change and we reported it where it was most relevant.

Discussion

Summary of main results

Evidence from 5 studies (3 RCTs) consisting of 293 participants contributed data to the primary outcomes of the comparison of OAGB compared to LSG and was mainly of low to moderate quality grading. For OAGB compared to RYGB, evidence is from 5 studies, 498 participants with similar quality grading. We have no evidence from RCTS looking at the cost implications of these procedures apart from operation time hospital stay and differences in number of staples used.

- There is probably no difference in comorbid resolution between the 3 methods apart from at 5 years when OAGB results in better diabetic resolution.
- OAGB probably results in better EWL% than LSG and RYGB.
- OAGB takes a shorter time to perform than LSG and longer than RYGB.
- There is probably no difference in QOL between OAGB. and RYGB but better QOL than LSG in those with comorbidities.

- There is probably no difference between the 3 methods in malnutrition rates post-surgery and reoperation rates.
- There is probably no difference in bile reflux between OAGB and LSG, but OAGB probably results in more bile reflux than RYGB.

Overall completeness and applicability of evidence

None of the studies looked at children. None were done in Africa and very few in Europe. Therefore, the results of this review are only applicable to adults and may still not be representative of all the adult populations. Moreover, the question we aimed to answer of the most optimal method in resource limited settings was not answered due to inability to define the settings of the research done as low income or high income as well as absence of data on cost. The review process probably did not cover obese populations and trials in populations where obesity is defined as BMI >27 i.e. Taiwan resulting in the trials not meeting our prespecified inclusion criteria **(75)**. Our dataset also covers outcomes up to 5 years therefore we cannot comment whether observed benefits are maintained over a longer period or whether some adverse events i.e., development of gastric cancer are underestimated. Moreover, the data for 5 years is from single studies.

Certainty of the evidence

We have limited to moderate confidence in our outcomes. This is mainly due to high risk of bias due to poor or not described study methods in terms of randomisation and blinding and imprecision. The reasons for downgrading are explained in the summary of findings tables. We did not downgrade any study for , as we were unable to assess for it using funnel plots as we had too few included studies. Cochrane methods recommend to only use funnel plots with at least 10 studies because with few studies the power of the tests is too low to distinguish chance from real asymmetry **(41)**

Potential biases in the review process

We performed a thorough and systematic literature search using two separate search strategies and our search input was very broad. However, the possibility of missing relevant trial data remains because of potential publication bias evident from studies reported in conferences that are not published which we opted not to include in the meta-analysis. Nevertheless, the general results in the abstracts in terms of comorbid resolution, weight loss and operation time seems to echo those of our meta-analysis. However, 2 studies in the comparison against LSG, one of them with 167 patients report better comorbid resolution in the OAGB group potentially have the ability to shift this analysis to a better comorbid resolution in OAGB if these 2 studies had been included in the meta-analysis. Some authors also reported data for outcomes in a manner that it could not be used for metanalysis **(94)**. We ensured duplicate extraction and risk of bias assessments to minimise bias in the review process. None of the authors have conflict of interest in terms of these procedures and their use in bariatric surgery.

Agreements and disagreements with other studies or reviews

Several reviews have looked at these comparisons but included both cohort and RCTs.

Rutledge who first described OAGB reported outcomes on his 1274 cases**(27)**. EWL% in his series was 51%, 68% and 77% at 6, 12 and 2 years which is similar to the means reported in the included trials of -61% to -87.9% between 1 to 5 years. On the other hand, his mean operation time was 36.9 minutes with shortest time of 19 minutes which is far less than in the trials between 64 and 147 minutes. This can be probably explained by that he had high volumes thus experience in OAGB.

Our results are different from those reported by Wang after a meta-analysis comparing OAGB to LSG published in 2017 including 12 cohort studies and 2 RCTs (98). To quote “OAGB offers a lot of advantageous indexes than patients receiving sleeve gastrectomy, such as higher 1 and 5 year EWL%, T2DM, hypertension and obstructive sleep apnoea (OSA) remission rate, lower osteoarthritis remission rate, lower leakage rate, lower overall late complications rate, higher ulcer rate, lower gastroesophageal reflux disease (GERD) rate, shorter hospital stay and lower revision rate”. The were no differences only in short term complications and operation rates of which in our review LSG had significantly shorter times. This difference might be due to that we include only RCTs whilst Wang acknowledges that their results may be unreliable due to small sample sizes, biased data, and short follow up times. Similarly Magouliotis published the same year with seventeen included studies and reported increased weight loss, better comorbid remission and shorter hospital stay and less mortality than OAGB(99). Both authors felt well designed RCTs were required to further assess outcomes.

We compare our results for the RYGB comparison mainly with those of a most recent Metanalysis in 2019 **(36)**. This study had 16 studies included, 6 retrospective, 7 prospective and 3 RCTs, one of which was retracted and is not included in our review **(43)** possibly accounting for the difference in results. Contrary to our findings, the authors found increased malnutrition in the OAGB and increased bowel obstruction and internal hernia in the RYGB. Similar to our findings OAGB showed greater EWL% for 1 to 5 years i.e., at 1 year (MD -6.02(-8.84, -3.20) vs -7.35 (-10.21, -4.48) in our review. There are also no differences in the other adverse events and in hypertensive and dyslipidaemia remission. Bile reflux was not reported in this review. They also reported greater rates of DM remission in the OAGB contrary to our findings mainly limited to 2 trials and 41 patients and did not pick up any gastric or oesophageal carcinoma concerns.

Jia, author of the first metanalysis with RCTs only comparing OAGB and RYGB had 3 included trials and 722 patients including the trial later to be retracted. He reports more excess BMI loss only with the extended biliopancreatic limb and better T2DM remission after OAGB vs RYGB with no difference in adverse events including biliary reflux **(100)**.

Brosnan, using a modelled decision analysis shows OAGB has superior outcomes to LSG and RYGB in terms of QALY payoffs for patients with T2DM **(45)**. This is comparable to our results in terms of LSG but contrary to what we find compared to

RYGB where our 2 included RCTS show no difference. A review with 47 included studies 17 RCTs and 11 bariatric surgeries compared to lifestyle showed that at 1 year only the methods compared in this review offered better QOL but with different findings. **(101)**. RYGB performing better than LSG which was slightly better than OAGB. In this network meta-analysis their feeling is that distal OAGB is not promising in terms of QOL, and a longer biliopancreatic limb results in worse QOL than standard OAGB an outcome not reflected in our results.

For cost implications most studies compare bariatric surgery to medical intervention or do estimated economic models looking at tangible and intangible benefits of bariatric surgery to comment on its cost effectiveness**(56)**. Very few studies report on actual cost of the procedures. RYGB is estimated between $25000 to $30000 from admission to immediate postoperative care and Laparoscopic adjustable banding $15000**(82)**. A direct comparison is found on a website quoting cost of the procedure and 20 follow up appointments at $21,696 for LSG; $24,642 for OAGB and 26,884for RYGB**(102)**, information we could not get in our review. In a review comparing Laparoscopic adjustable banding (LAGB) to non-surgical intervention Picot noted that LAGB costed more but was more cost effective for class 1 and 2 obesity who had type 2 obesity mainly because of resolution of T2DM contributing to a reduction in incremental cost effectiveness ratio with time**(103)**. Such an analysis was not possible in our review as no RCTs report on costs and we were unable to use estimates as Picot did as this was not part of our study design.

Authors' Conclusions

Implications for practice

Our evidence from both comparisons is from small trials and it remains still uncertain. However apart from the concerns of bile reflux and malnutrition that still remain OAGB remains non inferior to the other methods of bariatric surgery. It results in significantly better weight loss and less theatre time than RYGB and in one study demonstrated use of less staples which contribute the bulk of the cost of inputs. From a clinical point of view the surgeons experience, patient priorities and comorbidities, availability of theatre time, endoscopy and nutritional supplement support should be considered when choosing a bariatric procedure for a patient. However, from the limited data we have, OAGB attains as good outcomes as RYGB which is the preferred option in most setting, with additional significantly better weight loss. Using surrogates of theatre time and number of staples used OAGB appears to save time and to be a cheaper option than RYGB.

Implications for research

More and bigger trials including other populations i.e., African, American, and European population and children are needed to evaluate bariatric surgery. Authors need to update trials with unknown status or those marked as completed with no

results. One of them marked as estimated completion in 2018 from 2014 looking at QOL has no results reported**(104)**. There is also need for better designed and executed studies particularly blinding the assessors of outcomes to reduce outcome assessment bias.

The question of duration of the 3 operations should now be regarded as answered as we had consistent results showing LSG takes the shortest time and RYGB the longest

Researchers need to report more on cost of the procedures to help inform decisions in low-income settings. More patient related outcomes like QOL and patient satisfaction should be looked at.

Complete nomenclature is now mandatory as gastric bypass leaves readers with ambiguity as to whether it is RYGB or OAGB in this current setting.

The nomenclature of partial and complete remission can still be improved as the difference depends on whether one is on medication and authors still don't attach a timeframe of remission to the definition as summarised by Captieux in a scoping review published in 2020**(105)**.

Registration and protocol

This review was registered under the international prospective register of systematic reviews (PROSPERO)(106). A protocol was prepared to guide the review process and a waiver was provided by the University of Cape town Ethics committee to proceed with the review. Data extraction forms and review process are found on a shared Dropbox folder for all the authors and all the analysis is available on a Revman file.

Acknowledgements

The authors would like to thank search specialist Anel Schoones and Vittoria Lutje for running the search outputs and Selvan Naidoo for doing the duplicate search of included studies.

University of Cape Town librarian Gill Morgan and Wendy Smith for acquiring some missing full texts.

Professor Alfred Musekiwa is acknowledged for reviewing the meta-analysis outputs.

Funding

We acknowledge funding that went towards the search output and duplicate search of included studies from Somerset Hospital research funding and Centre of Evidence - based health care, Stellenbosch University.

Feedback and dissemination of review findings:

The results of this study will be made known to the nurses, doctors, and hospital managers in the government system. This will help practising surgeons and students to be aware of the commonly used bariatric surgery options and their effectiveness, safety, and cost implications. Attempts will be made to publish this analysis in a national or international journal and disseminate the findings at national and international conferences. A plain language summary will also be written for patient information.

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Reference 44 to 85 below.

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Appendix

Data extraction form one anastomosis gastric bypass vs RYGB or sleeve gastrectomy

Table 1: Data extraction form one anastomosis gastric bypass vs RYGB or sleeve gastrectomy

Date:	
Extractor (initials):	
Trial ID:	
Paper Name:	
Journal:	
Trial details	
Trial Dates (from-to: dd/mm/yyyy):	
Country:	
Setting (Developing/developed)	
Currency (if cost evaluation outcome)	
Funding of trial:	
Trial Design:	
Duration of study:	
Sample size and Power calculations:	
Frequency and duration of follow-up: Include details of activity at each follow up visit e.g., Outcome measures/ symptom questionnaire	
Subgroup information	
Children/Adults	
Location	
Participants	
Inclusion Criteria:	Exclusion Criteria:

Data extraction form for study characteristics:

Characteristics:	OAGB	Control: RYGB	Control: Sleeve	Total:
Number of participants:				
Sex ratio (Male: Female):				
Age Range (years):				
Mean/Median age (years):				
BMI (range):				
Race proportions				
Intervention and control groups (tick)				
Type of surgery				
Indication of surgery				
Was any Resource input evaluation included in the study?				
If yes what was the question?				
Were all treatment groups comparable at baseline? If 'No/unclear' Describe:		Yes No Unclear (circle)		
Participants with/without outcomes:				
	OAGB	**Control RYGB**	**Sleeve**	**Definition/Notes:**
Participants randomised:				
Participants with no treatment Outcome (total):				
• Excluded after randomisation				
• Lost to follow up				
• Other reasons				
Total per protocol analysed				
Total intention to treat				
Notes:				

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Interventions				
	OAGB	**RYGB**	**Sleeve**	**Location of Information in paper:**
Description: of procedure Major descriptors including limb size				

Open /laparoscopy/Not specified				
Any follow up revisions and type				
Other details e.g., co-interventions: ex: diet, etc				

Data extraction for results form:

Date:				
Extractor (initials):				
Trial ID:				
Paper name:				
Journal:				
Primary outcomes. n/N or mean (SD)				
	OAGB	**RYGB**	**Sleeve gastrectomy**	**Definition of endpoint /Time frame**
Dm				
Definition i.e., resolution / remission				
Hypertension				
Definition:				
Osteoarthritis				
Definition:				
Weight loss				
Definition -EWL, actual weight loss				
Other Comorbidity resolution				
Definition				
Quality of life measure				
Patient satisfaction scores				
Notes:				

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Other Outcomes	**0AGB**	**RYGB**	**Sleeve gastrectomy**	**Definition**
Resource input				
operative time				
Mean/ Median				
hospital stay				
Mean /Median				
Monetary costs				
Readmission (no./reasons)				
Reoperation (no./reasons)				

Adverse events (n/N)				
	OAGB	Control	Control 2	Location in paper and comments:
Adverse effects using Calvien- Dindo				
Grade 1.				
Grade II				
Grade III-				
Grade III-a				
Grade III-b				
Grade IV-				
Grade IV-a				
Grade IV-b				
Other Adverse Effects				
1.Anastomotic leaks				
2.Malnutrition requiring supplements				
3.Intraabdominal bleed				
4.Hernia				
5.Bowel obstruction				
6. Reoperation rates				
Mortality				Causes

Other important information	
Relevant papers cited:	
Other reported outcomes not analysed:	
Additional Information required from authors:	
Authors contacted?	Yes No (circle)
Address:	
E-mail:	
Telephone:	
Data obtained?	Yes No Awaiting response (circle)
Comments:	

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Table 2: Risk of bias data extraction form

Study details

Reference	

Author doing analysis:

Study design

- X Individually-randomized parallel-group trial
- ☐ Cluster-randomized parallel-group trial
- ☐ Individually randomized cross-over (or other matched) trial

For the purposes of this assessment, the interventions being compared are defined as

Experimental:	OAGB	Comparator:	

Specify which outcome is being assessed for risk of bias	DM remission
Specify the numerical result being assessed. In case of multiple alternative analyses being presented, specify the numeric result (e.g., RR = 1.52 (95% CI 0.83 to 2.77) and/or a reference (e.g., to a table, figure or paragraph) that uniquely defines the result being assessed.	

Is the review team's aim for this result…?

- ☐ to assess the effect of assignment to intervention (the 'intention-to-treat' effect)
- ☐ to assess the effect of adhering to intervention (the 'per-protocol' effect)

If the aim is to assess the effect of adhering to intervention, select the deviations from intended intervention that should be addressed (at least one must be checked):

- ☐ occurrence of non-protocol interventions
- ☐ failures in implementing the intervention that could have affected the outcome
- ☐ non-adherence to their assigned intervention by trial participants

Which of the following sources were <u>obtained</u> to help inform the risk-of-bias assessment? (Tick as many as apply)

- ☐ Journal article(s) with results of the trial
- ☐ Trial protocol
- ☐ Statistical analysis plan (SAP)
- ☐ Non-commercial trial registry record (e.g., ClinicalTrials.gov record)
- ☐ Company-owned trial registry record (e.g., GSK Clinical Study Register record)
- ☐ "Grey literature" (e.g., unpublished thesis)
- ☐ Conference abstract(s) about the trial
- ☐ Regulatory document (e.g., Clinical Study Report, Drug Approval Package)
- ☐ Research ethics application
- ☐ Grant database summary (e.g., NIH Reporter or Research Councils UK Gateway to Research)
- ☐ Personal communication with trialist
- ☐ Personal communication with the sponsor

Risk of bias assessment

Domain 1: Risk of bias arising from the randomization process

Signalling questions	Comments	Response options
1.1 Was the allocation sequence random?		Y / PY / PN / N / NI
1.2 Was the allocation sequence concealed until participants were enrolled and assigned to interventions?		Y / PY / PN / N / NI
1.3 Did baseline differences between intervention groups suggest a problem with the randomization process?		Y / PY / PN / N / NI
Risk-of-bias judgement		Low / High / Some concerns
Optional: What is the predicted direction of bias arising from the randomization process?		NA / Favours experimental / Favours comparator / Towards null /Away from null / Unpredictable

Domain 2: Risk of bias due to deviations from the intended interventions (effect of assignment to intervention)

Signalling questions	Comments	Response options
2.1. Were participants aware of their assigned intervention during the trial?		Y / PY / PN / N / NI
2.2. Were carers and people delivering the interventions aware of participants' assigned intervention during the trial?		Y / PY / PN / N / NI
2.3. If Y/PY/NI to 2.1 or 2.2: Were there deviations from the intended intervention that arose because of the trial context?		NA / Y / PY / PN / N / NI
2.4 If Y/PY to 2.3: Were these deviations likely to have affected the outcome?		NA / Y / PY / PN / N / NI
2.5. If Y/PY/NI to 2.4: Were these deviations from intended intervention balanced between groups?		NA / Y / PY / PN / N / NI
2.6 Was an appropriate analysis used to estimate the effect of assignment to intervention?		Y / PY / PN / N / NI
2.7 If N/PN/NI to 2.6: Was there potential for a substantial impact (on the result) of the failure to analyse participants in the group to which they were randomized?		NA / Y / PY / PN / N / NI
Risk-of-bias judgement		Low / High / Some concerns
Optional: What is the predicted direction of bias due to deviations from intended interventions?		NA / Favours experimental / Favours comparator / Towards null /Away from null / Unpredictable

Domain 2: Risk of bias due to deviations from the intended interventions (effect of adhering to intervention)

Signalling questions	Comments	Response options
2.1. Were participants aware of their assigned intervention during the trial?		Y / PY / PN / N / NI
2.2. Were carers and people delivering the interventions aware of participants' assigned intervention during the trial?		Y / PY / PN / N / NI
2.3. [If applicable:] If Y/PY/NI to 2.1 or 2.2: Were important non-protocol interventions balanced across intervention groups?		NA / Y / PY / PN / N / NI
2.4. [If applicable:] Were there failures in implementing the intervention that could have affected the outcome?		NA / Y / PY / PN / N / NI
2.5. [If applicable:] Was there non-adherence to the assigned intervention regimen that could have affected participants' outcomes?		NA / Y / PY / PN / N / NI
2.6. If N/PN/NI to 2.3, or Y/PY/NI to 2.4 or 2.5: Was an appropriate analysis used to estimate the effect of adhering to the intervention?		NA / Y / PY / PN / N / NI
Risk-of-bias judgement		Low / High / Some concerns
Optional: What is the predicted direction of bias due to deviations from intended interventions?		NA / Favours experimental / Favours comparator / Towards null /Away from null / Unpredictable

Domain 3: Missing outcome data

Signalling questions	Comments	Response options
3.1 Were data for this outcome available for all, or nearly all, participants randomized?		Y / PY / PN / N / NI
3.2 If N/PN/NI to 3.1: Is there evidence that the result was not biased by missing outcome data?		NA / Y / PY / PN / N
3.3 If N/PN to 3.2: Could missingness in the outcome depend on its true value?		NA / Y / PY / PN / N / NI
3.4 If Y/PY/NI to 3.3: Is it likely that missingness in the outcome depended on its true value?		NA / Y / PY / PN / N / NI
Risk-of-bias judgement		Low / High / Some concerns
Optional: What is the predicted direction of bias due to missing outcome data?		NA / Favours experimental / Favours comparator / Towards null /Away from null / Unpredictable

Domain 4: Risk of bias in measurement of the outcome

Signalling questions	Comments	Response options

4.1 Was the method of measuring the outcome inappropriate?		Y / PY / PN / N / NI
4.2 Could measurement or ascertainment of the outcome have differed between intervention groups?		Y / PY / PN / N / NI
4.3 If N/PN/NI to 4.1 and 4.2: Were outcome assessors aware of the intervention received by study participants?		NA / Y / PY / PN / N / NI
4.4 If Y/PY/NI to 4.3: Could assessment of the outcome have been influenced by knowledge of intervention received?		NA / Y / PY / PN / N / NI
4.5 If Y/PY/NI to 4.4: Is it likely that assessment of the outcome was influenced by knowledge of intervention received?		NA / Y / PY / PN / N / NI
Risk-of-bias judgement		Low / High / Some concerns
Optional: What is the predicted direction of bias in measurement of the outcome?		NA / Favours experimental / Favours comparator / Towards null /Away from null / Unpredictable

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Domain 5: Risk of bias in selection of the reported result

Signalling questions	**Comments**	**Response options**
5.1 Were the data that produced this result analysed in accordance with a pre-specified analysis plan that was finalized before unblinded outcome data were available for analysis?		Y / PY / PN / N / NI
Is the numerical result being assessed likely to have been selected, on the basis of the results, from...	-	-
5.2. ... multiple eligible outcome measurements (e.g., scales, definitions, time points) within the outcome domain?		Y / PY / PN / N / NI
5.3 ... multiple eligible analyses of the data?		Y / PY / PN / N / NI
Risk-of-bias judgement		Low / High / Some concerns
Optional: What is the predicted direction of bias due to selection of the reported result?		NA / Favours experimental / Favours comparator / Towards null /Away from null / Unpredictable

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Overall Risk of Bias

Risk-of-bias judgement	Low / High / Some concerns
Optional: What is the overall predicted direction of bias for this outcome?	NA / Favours experimental / Favours comparator / Towards null /Away from null / Unpredictable

Risk of bias: Adverse events

Adverse Event Criterion	Assessment	Explanation	Comments
Number of adverse events reported	—	We will extract the adverse events reported	
Was monitoring active?	Y N Unclear	We will classify monitoring as 'active' when authors reviewed participants at set timepoints and enquired about symptoms.	
Timing of outcome reporting Was number and timing of outcome measures adequate?	Adequate(Y) Inadequate(N)	We will classify the number and timing of tests as 'adequate', when tests were taken at baseline, on two other timepoints within the study period including after the intervention and after We will classify the number of tests taken as "inadequate", if either the baseline measures in the first week or measures after intervention were not performed.	
Was blinding for participants and outcome assessors adequate?	Y N Unclear	We will classify blinding as 'adequate' when both participants and outcome assessors were blinded to the intervention group, and the methods of blinding (including use of a placebo) were described.	
Was outcome data reporting complete?	Y N Unclear	We will classify outcome data reporting as 'complete' when data was presented for all the time-points where it was collected. For the trials with inadequate number of outcome measures taken, we will consider completeness of reporting as inconsequential, and therefore record judgement as unclear	
Were all participants included in reporting?	Y N	We will report the percentage of randomized participants included in adverse event reporting.	
Was the analysis independent of study sponsor?	Yes No Unclear	We will classify the analysis of trials sponsored by pharmaceutical companies as independent of the sponsor when it was clearly stated that the sponsor had no input to the trial analysis	

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Table 3: OAGB versus sleeve gastrectomy conference abstracts RCTS

Author/ Year	Country	Title / URL	Conference	Study Objective	Population	Outcomes	Study summary findings
Albanopoulos /2013	Greece	Laparoscopic Gastric Mini Bypass vs. Laparoscopic Sleeve Gastrectomy for Treatment of Morbid Obesity. Preliminary Results of a Prospective Randomized Study.	18th World Congress of the International Federation for the Surgery of Obesity & Metabolic Disorders (IFSO), Istanbul, Turkey /Obesity Surgery.	Compare LMGB and LSG.	116 LSG and 26 LMGB. 33,8% male 66,2% female.	Mean BMI, hospital stay, length of operation, trocars placed, intraoperative and postoperative complications.	The mean BMI, hospital stay and postoperative complications for the two groups were not statistically different. Statistically significant differences were observed in the duration of the operation (sleeve vs mini bypass: 44,82 min vs 60,21, p< 0,001), the number of intraoperative complications (sleeve vs mini bypass: 22,7%vs 0,7%, p< 0,009).
Bedi 2017	India	LSG vs OAGB-1 year follow-up data- a randomized control trial gastric bypass procedures including Roux-en-y gastric bypass (RYGB) and one anastomosis gastric bypass (OAGB)/MGB https://www.cochranelibrary.com/central/doi/10.1002/central/CN-01462483/full	22nd World Congress of the International Federation for the Surgery of Obesity and Metabolic Disorders, IFSO 2017. London. United Kingdom.	Compare the 1 year follow up results of LSG and OAGB in terms of weight loss, resolution of comorbidities and complications.	100 LSG and 90 OAGB mean BMI 44.9 and 45.1 respectively.	Percentage of EWL at 1 yr., diabetes and hypertension remission	OAGB has slightly better excess weight loss and DM remission, but not significantly different at 1 year,
Bhandarwar 2017	India	Laparoscopic MGB vs LSG: metabolic surgery for morbid obesity with remission of diabetes and comorbidities and effective weight loss. https://www.cochranelibrary.com/central/doi/10.1002/central/CN-01362664/full	2017 Scientific Session of the Society of American Gastrointestinal and Endoscopic Surgeons, SAGES 2017.	To assess efficacy of laparoscopic MGB by comparing with LSG in terms of weight loss and remission of DM and other	Mostly Asian population 43 MGB, 42 LSG	Loss of weight, diabetes and hypertension remission. Obstructive sleep apnoea and dyslipidaemia.	OAGB has more and effective weight loss and comorbidity resolution compared to LSG

			Houston, TX. United States.	comorbidities at 6, 12 and 24 months			
Elmaleh H 2019	Egypt	Short term results of a randomized controlled trial on the effect of laparoscopic one anastomosis gastric bypass versus laparoscopic sleeve gastrectomy in treatment of obese type 2 diabetic patients. https://www.cochranelibrary.com/central/doi/10.1002/central/CN-01996517/full	The 36th ASMBS Annual Meeting. Las Vegas. United States.	To compare laparoscopic one anastomosis gastric bypass (OAGB) and laparoscopic sleeve gastrectomy (SG) regarding the efficacy of control of T2D in obese patients	162 obese with T2DM	Diabetes remission	OAGB had better effect than SG in diabetes remission
Goyal 2020	United states	Glycaemic control in patients achieving diabetes remission with weight loss by bariatric surgery through Laparoscopic Sleeve Gastrectomy (LSG) compared with One Anastomosis Gastric Bypass (OAGB) - Five year follow up data of randomised control trial. https://www.cochranelibrary.com/central/doi/10.1002/central/CN-02213337/full	2020 American Association of Clinical Endocrinologists Annual Scientific and Clinical Congress, AACE 2020. Washington DC. United States.	Compare 5-year follow-up results of One Anastomosis Gastric Bypass / Mini Gastric Bypass (MGB-OAGB) and Laparoscopic Sleeve Gastrectomy (LSG).	37 LSG and 41 OAGB BMI >35kg/m^2 and <60kg/m^2.	Change in HBAIC and weight loss.	The difference between the groups was statistically significant from fourth year follow up onwards with greater metabolic benefits observed in the MGB-OAGB group.

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Table 4: *One anastomosis gastric bypass versus Roux -n-Y gastric bypass Conference abstracts RCTS*

Author	Country	Title / Link	Conference	Objective	Population	Outcomes	Conclusion
Bhandarwar 2017	India	Comparative study between mini-gastric bypass and Roux-En-Y gastric bypass in Asian population.	2017 Scientific Session of the Society of American Gastrointestinal and Endoscopic Surgeons, SAGES 2017. Houston, TX. United States.	Compare LMGB and RYGB in terms of weight loss and comorbid reduction and rate of complications	Asian. 51 patients each underwent MGB and RYGB.	Operative time, complications, reoperation rate, weight loss, BMI reduction, glycosylated haemoglobin and dyslipidaemia.	No significant difference was found in terms of BMI, diabetes control, dyslipidaemia and anastomotic leak rate. Therefore, Mini-gastric bypass seems to be equally efficacious to roux en y gastric bypass in terms of outcomes and complication rate.
Elkeleny 2017	Egypt	Prospective randomized trial comparing laparoscopic roux-en-Y vs. Mini-gastric bypass for the treatment of morbid obesity: short term outcomes. https://www.cochranelibrary.com/central/doi/10.1002/central/CN-01400101/full	25th International Congress of the European Association for Endoscopic Surgery, EAES 2017. Frankfurt. Germany. / Embase	Compare LRYGB vs. LMGB in management of morbidly obese patients r	50 morbidly obese patients divided into 2 groups.	Mean operative and postoperative parameter, amelioration of comorbidities, weight loss post-operative and Glucagon like peptide-1 (GLP-1	Shorter operative and hospital stay with higher mean excess BMI loss percent for LMGB. No difference for comorbid resolution, intraoperative and postoperative complications.
Garcia 2019	Spain	Prospective randomized trial of OAGB vs. LRYGB, weight results in the first 18 months after surgery. https://doi.org/10.1007/s11695-019-04101-1	24th IFSO World congress.	Comparing OAGB to LRYGB.	10 in each group. BMI 40-50KG/m2.	EWL	Significantly different percentage of excess weight loss and percentage of excess body mass

							index loss (p<0.05) at 3,6,9,12, and 18 months between the two groups, with greater weight loss in the OAGB group.
Kraljevic 2019	Switzerland	Laparoscopic one anastomosis gastric bypass versus laparoscopic Roux-en-Y gastric bypass in the treatment of obesity: 1-year outcomes of the RCT. https://www.cochranelibrary.com/central/doi/10.1002/central/CN-01986751/full	24th World Congress International Federation for the Surgery of Obesity and Metabolic Disorders, IFSO 2019. Madrid. Spain.	Compare effectiveness and safety of LOAGB and LRYGB.	40 LOAGB and 40LRYGB	EWL morbidity	OAGB and LRYGB were equally effective regarding excessive weight loss 6 weeks after surgery and significantly better weight loss in LOAGB after 1 year. There was no difference in morbidity between the groups.
Pazouki 2019	Iran	Excessive weight loss following laparoscopic gastric mini bypass or Roux-en-y gastric bypass surgery gastric bypass procedures including Roux-en-y gastric bypass (RYGB) and one anastomosis gastric bypass (OAGB)/MGB. https://www.cochranelibrary.com/central/doi/10.1002/central/CN-01462481/full	22nd World Congress of the International Federation for the Surgery of Obesity and Metabolic Disorders, IFSO 2017. London. United Kingdom.	Compare weight loss one year after Laparoscopic mini gastric bypass versus RYGB.	75 obese patients aged 18 to 59.	EWL	EWL after one month, six months nine months and one year between the two groups was significant and was more in Mini Gastric Bypass ($p < 0.05$).
Lee / 2009	China	Laparoscopic Mini-gastric bypass versus roux-en Y gastric bypass: 5-year results and final report of a randomized trial.	International federation for the surgery of	Compare LRYGB and LMGP and	282 LMGBP	Surgical time, EWL,	LMGBP is a simpler and safer procedure taking less surgical

			obesity and metabolic disorders. XIV congress France.	report 5-year trial results.	versus 40 LRYGB.	complication rates, mortality.	time with no difference in EWL, complication, revision rates and QOL.
Robert 2018[a]	United states	Efficiency and safety of One Anastomosis Gastric Bypass versus Roux-en-Y Gastric Bypass: preliminary data of the YOMEGA randomized controlled trial.	ASMBS 35th annual meeting at obesity week 2018 abstracts. United States.	Compare weight loss and serious adverse events between OAGB and RYGB.	129 OAGB and 124 RYGB.	Excess body mass index loss (EBL%) Serious adverse events.	No significant difference of weight loss after 1 year between OAGB and RYGB, slightly lower levels of HbA1c and serum albumin after OAGB and a higher risk of SAE after OAGB.
Ruiz Tozar 2018[ab]	Spain	Mid- and long-term evolution of weight loss after sleeve gastrectomy (SG), Roux-en-Y gastric bypass (RYGB) and one-anastomosis gastric bypass (OAGB): a comparative study. https://www.cochranelibrary.com/central/doi/10.1002/central/CN-01605180/full	8th Congress of the International Federation for the Surgery of Obesity and Metabolic Disorders - European Chapter, IFSO-EC 2018. Athens. Greece.	Compare short- and long-term weight loss between OAGB, RYGB and SG.	200 in each group.	EWL%	OAGB achieve superior mid- and long-term weight loss than the other techniques. 5 years after surgery the patients who underwent SG and RYGB had recidivism while after OAGB, anthropometric parameters remain in normal weight range.

Singh B 2019	India	One anastomosis gastric bypass versus Roux- en-Y gastric bypass for T2DM in obese subjects: a randomised controlled trial https://www.cochranelibrary.com/central/doi/10.1002/central/CN-01987923/full	24th World Congress International Federation for the Surgery of Obesity and Metabolic Disorders, IFSO 2019, Madrid Spain	To compare impact of RYGB and OAGB on T2DM in morbidly obese diabetic patients	23 (12 RYGB and 11 OAGB) morbidly obese T2DM patients.	T2DM remission.	Both RYGB and OAGB are comparable in terms of impact on T2DM.

[an] Included trial (excluded as duplicate)

[b] retracted (excluded duplicate)