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Efficacy and Safety of Gastric Greater Curvature Plication Compared with Sleeve Gastrectomy: Systemic Review and Meta-Analysis

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Abstract

Background: Obesity has become one of the common health problems affecting people with significant morbidity and mortality. Manage effectively by bariatric surgeries.

Objectives: The aim of our review is to collect and analyze available data from controlled studies to assess the effectiveness and safety of laparoscopic greater curvature plication in comparison to laparoscopic sleeve gastrectomy.

Materials and Methods: MEDLINE, EMBASE, and Cochrane collaboration library were searched until July 2020 for literature published.

Results: Sixteen articles were eligible for inclusion comprising a total of 1313 patients, of whom 601 had undergone LGCP and 712 LSG. The percentage of excess weight loss (%EWL) was significant favors sleeve in RCTs at 6 months and 12 months with mean difference -5.37 and -10.56 respectively, and for observational studies at 6 months and 12 months with mean difference -12.43 and -14.81 respectively.

Plication was associated with a non-significant lower risk of leakage (OR 0.31) and of bleeding (OR 0.35). Reoperation was more in plication than sleeve in both RCTs and in observational studies, (OR 2.27 and 1.73), respectively.

No significant difference was observed regarding hospital course, except for operation time in RCTs which is in favors to Plication while in observation in favors to sleeve.

The Type 2 Diabetes Mellitus (T2DM) and hypertension remission were un-significantly different between both procedures.

Conclusion: This systematic review suggests that plication is less effective to sleeve in terms of weight reduction, but comparable in terms of complications and hospital course. However, unless there is emerging a new promising result, plication procedures should be disparaged.

Keywords: Bariatric surgery; Sleeves; Plication; Obesity; Morbidity; Mortality

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Introduction

One of the most sources of trouble and worry regarding the health of the 21st century is the obesity. It was estimated in 2014 that more than 1.9 billion adults were overweight, of these, more than 600 million were obese, and the rate is continuously increasing worldwide [1].

According to epidemiological studies, obesity has become one of the common health problems affecting people of both sex and all age groups in Saudi Arabia [2-4]. The prevalence of overweight and obese among adults was 36% and 35.6% respectively. The problem with obese patients that they have a risk for an increase morbidity and mortality. It is the main risk factor for many chronic diseases such as diabetes, cardiovascular diseases, which can lead to death, and risk of some cancers. The risk of these diseases rises following the increase in BMI [5-7].

Concurrently research on possible treatment for obesity has been ongoing, with a strong agreement that bariatric surgeries are the most effective and enduring treatment for clinically morbid obesity [7]. Bariatric surgeries promote weight loss by changing the digestive system's anatomy, limiting the amount of food that can be eaten and digested. It results in long-term weight loss, remission of obesity-related comorbidities and improve the life quality [8,9]. The Over-growing field of bariatric surgeries has presented a wide range of procedures, which classified to restrictive (gastric banding, gastric sleeve, gastric plication), restrictive with mild malabsorptive (Roux-en-Y gastric bypass), and malabsorptive with mild restrictive (duodenal switch) [6].

During the last few years, Laparoscopic Sleeve Gastrectomy (LSG) has considerably grown in popularity worldwide [10,11]. A bariatric surgical treatment in which a large portion of the stomach is removed, leaving a 60 ml to 80 ml gastric tube. The greater curvature of the stomach is resected during the procedure. The small residual stomach tube prevents over eating by creating a feeling that the stomach is full after a small meal. Various studies suggest LSG has metabolic improvement and weight reduction reaching to 80% [12]. But the main drawback for the sleeve is the severity of complications, mainly leaks from staple line 1% to 3% and bleeding 0% to 6.4%, which is difficult to manage [13-16]. To reduce critical complications, a novel restrictive procedure was introduced: Laparoscopic Greater Curvature Plication (LGCP). An operation that decreases the stomach volume by folding it into itself with stitches without resection. The idea of laparoscopic gastric plication is similar to that of laparoscopic sleeve, with an outcome of gastric tube creation with an elimination of the greater curvature. In addition, plication has advantages of a reverse restrictive and low risk of leakage. However, the long-term efficacy is under investigation [17,18].

The aim of our review was to collect and analyze available data from controlled studies to assess the effectiveness and safety of laparoscopic greater curvature plication in comparison to laparoscopic sleeve gastrectomy.

Materials and Methods

Review question (PICO)

Is laparoscopic adjustable gastric plication (LGCP) superior to Laparoscopic Sleeve Gastrectomy (LSG) in reducing weight of obese patients and other efficacy and safety outcomes?

P: Obese patients.

I: laparoscopic adjustable gastric plication (LGCP).

C: laparoscopic sleeve gastrectomy (LSG).

O: Excess weight loss (%EWL), resolution of obesity-related comorbidities, complication, re-operation, operation time, blood loss and leak and postoperative hospital stay.

Search

The review methods including eligibility criteria, analysis and manuscript writing were stated and documented according to the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guideline [19]. A systematic search was conducted in MEDLINE, EMBASE, and the Cochrane collaboration library for literature published from database inception through July 2020; we used both keywords and Medical Subject Headings (MESH), with no language restriction. The search terms included: Obesity; overweight; body mass index; laparoscopic; laparoscopy; endoscopy; bariatric surgery; gastric plication; gastric imbrication; adjustable gastric banded plication; Laparoscopic Gastric Greater Curvature Plication; LAGBP; LGGCP; greater curvature plication; LGCP; laparoscopic adjustable gastric banding; sleeve gastrectomy; and LSG. All relevant articles were also searched manually to identify other related studies.

Inclusion criteria and study selection

We systematically reviewed published studies according to Population, Interventions, Comparators, Outcome Measures, And Setting (PICOTS) criteria: Adult, both genders, all races, obese population defined by BMI above 30 kg/m^2, with or without co-morbidities. LGCP with or without a band, endoscopic or laparoscopic is the intervention; compared to LSG. The study reported outcomes are excess weight loss and other information on efficacy or safety. Any type of comparative study will be included randomized control trial or observational studies. The exclusion criteria included pediatric population, other bariatric surgery, overlapping data, case series, case reports, and conference abstracts.

Three authors (MH, EA, and DF) performed an independent review of the abstracts for inclusion or exclusion. References were recommended for full-text review if the study was expected to provide evidence to answer the clinical questions.

Data extraction

Two authors (MH, EA) independently extracted the following data from each study: year of publication, prospective or retrospective study design, enrollment period, number of patients included, mean age, gender distribution, mean BMI, excess weight loss (%EWL), resolution of obesity-related comorbidities, complication, re-operation due to complications or failure of weight loss, operation time, and postoperative hospital stay. The summarized results were cross-checked again. Disagreements were arbitrated by consensus with the two authors (MF, DF).

Quality assessment

Methodological quality and risk of bias of each study were determined according to the Cochrane Collaboration criteria [20] for randomized controlled trials (RCTs) and to the Newcastle-Ottawa Scale for non-RCTs [21] by three reviewers (MF, MH, EO).

Statistical analysis

A statistical analysis was performed on the extracted data using Review Manager Software (Rev Man version 5.2.) [22]. The random effect model was employed for pooling data, using Der Simonian and Laird test. Odds Ratio (OR) and 95% Confidence Interval (CI) were computed for dichotomous data and mean difference for continuous data.

The presence of heterogeneity was tested utilizing the conventional Cochrane's Q test and the I^2 test. The P value for Q test is considered significant when it is <0.10.

Definitions

Laparoscopic gastric plication: a restrictive bariatric procedure, by invagination of the greater curvature of the stomach by submucosal sutures.

Laparoscopic sleeve gastrectomy: a restrictive bariatric procedure, consisting of subtotal vertical gastrectomy, to create a tubular stomach.

Excess weight loss %: one of the most used expressions of weight

Table 1: Shows the characteristics of these studies including author, year of publication, study design, number of patients, number and % of female, mean age, baseline BMI, quality, the percentage of excess weight loss and quality score.

No.	References	Study type	Interventions No of patients	Female N (%)	Age (years) mean (SD)	Baseline BMI (kg/m²) mean (SD)	percentage of excess weight loss		Quality grade
1	Grubnik [31] Ukraine Kazakhstan	RCT	LGCP 25 LSG 27	20 20	40.5 ± 5.2 44.2 ± 6.8	41.6 ± 6.5 45.8 ± 7.2	**At 6 month** 49.8 ± 15.4 51.8 ± 13.9 **At 12 months** 45.8 ± 17% 59.5 ± 15.4	**At 24 M** 42.4 ± 18% 78.9 ± 20% **At 36 M,** 20.5 ± 23.9 72.8 ± 22	
2	Abouzeid [24] Egypt	randomized comparative study	25 LGCP 25 LSG	16 18	32.1 ± 8.8 34.8 ± 11.3	47.8 46.8	**At 12 months:** 45.4% 66.4		
3	Sharma [25] India	Randomized Double-Blinded Trial	15 LGCP 15 LSG	6 6	40.5 39.9	44.7±6.1 44.0±7.8	**AT 6M:** 40.1 ± 15.1 43.9 ± 16.5 **At 12M** 42.1 ± 13.0 53.8 ± 19.5	**At 36 M** 39.5 ± 14.4 50.0 ± 20.3	
4	Verdi [26] Italy	retrospective non-randomized case-control series	45 LGCP 45 LSG	39 39	37.8 ± 11.45 40 ± 9.14	40.65 ± 4.99 41 ± 5.07	**At 3M** 34.7 ± 18.7 38 ± 22.79	**At 6 month** 40.2 ± 25 57 ± 30.89	7
5	Chouillard [32] Multi-centers	A case-control study comparing	LGCP 40 LSG 40	36 36	34.2 ± 8.15 35.4 ± 6.65	40.4 ± 4.01 41.2 ± 5.17	**At 6M** 38.6 % ± 13.59 46.2 % ± 17.7 At 12 M 51.9 % ± 13.7 61.2 % ± 14.7	**At 18 months**: 56.5 + 9.8% 71.3 + 10.4	6
6	Toprak [29] Turkey	Retrospectively analyzed	LGP 29 LSG 26	6 5	35.5 ± 11.2 33.9 ± 10.4	41.4 ± 3.0 42.0 ± 3.1	**6. month (BMI)** 30.7 ± 1.9 29.7 ± 1.9	**12. month (BMI)** 27.3 ± 2.0 26.0 ± 1.8	8
7	Lee [30] Taiwan	PROSPECTIVE STUDY	42 42	21 28	32.6 _ 9.7 32.1 _ 8.6	40.7 _ 6.1 40.7 _ 6.1	At 12 M 62.6 _ 21.5 67.2 _ 18.3		7
8	Abdelbaki [25] Egypt	Retrospective	62 LGGCP 78 LSG	50 (81%) 57 (73%)	34.45 ± 10.7 31.77 ± 9.17	41.62 ± 7.1 48.27 ± 6.9	**6 month** 40.4 ± 11.9% 47.1 ± 13.9%	**At 12 M** 52.1 ± 15.1% 68.1 ± 15.8%	6
9	Chaudhry [34] U.S.A	Retrospective	17 LAGBP 17 LSG	82.4% 76.5%	42.5 ± 11.6 45.0 ± 9.8	47.7 ± 6.5 46.5 ± 4.8	**6-month** 33.3 ± 10%, 46.1 ± 8.9%	**12month** 46.1 ± 14.8 57.7 ± 16.0	6
10	Huang [27] China	Retrospective	30 30	21 18	30.37 ± 8.22 32.77 ± 8.17	37.3 ± 3.8 37.44 ± 3.52	**At 1 M** 22.5 ± 8.03 25.19 ± 6.97 **at 3 month** 34.75 ± 9.98 45.39 ± 11.56 **at 6 month** 44.24 ± 12.75 57.78 ± 10.97 **at 9 month** 52.47 ± 14.22 65.23 ± 11.87	**at 12 month** 54.94 ± 18.42 73.14 ± 13.05 **at 18 month** 60.55 ± 18.91 70.12 ± 12.19 **at 24 month** 66.93 ± 17.13 67.22 ± 15.03	7
11	Shen, 2013 China	prospective nonrandomized study	19 20	14 13	33.9 ± 5.7 34.2 ± 6.3	37.3 ± 4.3 38.4 ± 6.3	**AT1 M**: 25.0 ± 10.3 31.4 ± 13.2 AT 3M 38.1 ± 10.4 50.0 ± 18.3	**AT6 M** 50.6 ± 15.1 67.8 ± 23.6 At 12M 58.8 ± 16.7 80.0 ± 26.8	7
12	Ahluwalia, 2015 China	Retrospective	42 LAGBP 97 LSG	34 (81%) 77 (79.4%)	31.67 ± 9.66 36.16 ± 10.81	32.76 ± 1.58 32.64 ± 1.49	**AT 1M:** 29.5 ± 10.04 32.19 ± 13.1 **AT 3M:** 44.93 ± 14.93 54.43 ± 17.99 **AT 6M:** 53.95 ± 16.47 66.85 ± 20.16 **AT 9M:** 60.1 ± 18.68 76.79 ± 21.81	**AT 12M**: 64.29 ± 20.62 79.75 ± 22.58 **AT 18M:** 66.45 ± 22.9 79.01 ± 21.86 **AT 24M:** 70.65 ± 21.49 75.69 ± 23.02	
13	Bužga, 2017 Czech	Prospective, Observational	43 LGCP 84 LSG	28 (58.3%) 61 (72.6%)	42.5 ± 8.0 42.0 ± 10.3	42.5 ± 5.5 43.7 ± 5.4	AT 3M: 34.1 ± 11.3 40.2 ± 16.8 AT 6M: 42.6 ± 17.4 55.0 ± 19.7	AT 12M: 49.3 ± 24.3 64.3 ± 28.4 AT 18M: 53.2 ± 27.2 65.4 ± 22.9	

No.	References	Study type	Interventions No of patients	Female N (%)	Age (years) mean (SD)	Baseline BMI (kg/ m²) mean (SD)	percentage of excess weight loss		Quality grade
14	Talebpour [37] Iran	RCT	35 LGP 35 LSG	27(77.1%) 29(82.9%)	35.34 ± 10.08 38.60 ± 10.27	48.39 ± 4.89 44.60 ± 3.50	**AT 3M:** 21.76 ± 8.47 29.23 ± 10.72	**AT 18M:** 68.99 ± 12.76 73.34 ± 15.82	
							AT 6M: 41.39 ± 12.03 49.65 ± 16.02	**AT 24M:** 72.87 ± 12.60 72.26 ± 11.91	
							AT 12M: 59.34 ± 12.35 65.45 ± 16.52		
15	Park, 2017 Korea	Retrospective	75 LGCP 74 LSG	67 (89.3%) 58 (78.4%)	32.6±6.7 30.4±7.9	33.7±3.3 34.7±53.6	**AT 3M**: 51.1 ± 16.9 47.8 ± 20.8	**AT 24M:** 70.5 ± 18.5 83.4 ± 28.7	
							AT 6M: 71.1 ± 20.2 74.5 ± 21.8	**AT 36M:** 67.3 ± 15.3 78.6 ± 31.7	
							AT 12M: 77.1 ± 18.4 87.8 ± 25.1		
16	Cottam [33] USA	Retrospective	57 LAGBP 57 SG	47 (82.5%) 47 (82.5%)	50.5 ± 12.5 43.9 ± 10.9	43.6 ± 6.5 43.5 ± 6.4	**AT 3M:** 28% ± 12.2% 44.6% ± 13.3%	**AT 12M:** 44.9% ± 19.2% 71.1% ± 22.1%	
							AT 6M: 36.4% ± 14% 61.7% ± 20.6%	**AT 18M:** 47.8% ± 21.2% 72.4% ± 22%	
							AT 9M: 41.3% ± 17.5% 67.7% ± 19.5%	**AT 24M:** 45.9% ± 25.3% 67.2% ± 25.7%	

loss, calculated as (Pre-op weight – follow up weight/ Pre-op weight – ideal body weight) % [23].

Reoperation: A need for another surgery for complication or failure to lose weight.

The I²: Statistic represents the proportion of heterogeneity of effects across trials that are not attributable to chance or random error. An I^2 value <25% was no heterogeneity, 25% to 50% as low heterogeneity, 50% to 75% to be of moderate heterogeneity, and more than 75% as high heterogeneity.

Results

Initially, the search retrieved 338 reports (Figure 1) shows the flow chart of selection process including justifications for exclusion. Seventy-four full-text relevant articles were retrieved. However, fifty-eight of them were excluded. Sixteen articles were eligible for inclusion in the meta-analysis [24-35]. The evidence (Table 1) shows the characteristics of these studies including author, year of publication, study design, number of patients, number and % of female, mean age, baseline BMI, quality, the percentage of excess weight loss and quality score. Four studies were randomized controlled trials with 202 patients (100 LGCP, 102 LSG), and 12 observational studies with 1111 patients (501 LGCP, 610 LSG).

The distribution of the 4 RCTs per countries is Ukraine, Egypt, Iran and India. While, the observational studies (9 retrospective cohorts from Italy, U.S, Korea, Egypt, Turkey, and China, 2 prospective cohorts from Taiwan and Czech, 1 multi-centric case-control and 1ry author from France). Also, 5 of the studies with banded plication.

(Figure 2) presents details for Risk of Bias (ROB) items within the included RCT studies, while observational studies score presented in (Table 1).

The studies were sub-grouped according to study design: randomized controlled trials and observational studies.

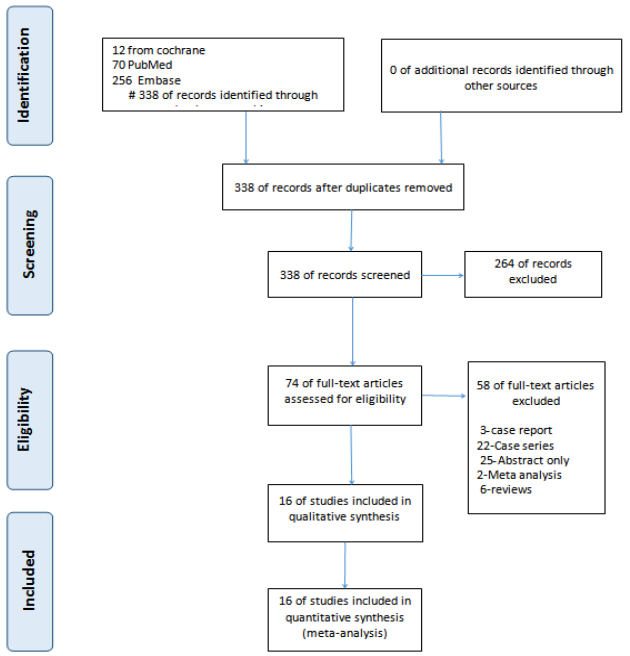

Figure 1: Selection process.

Excess weight loss percent (%EWL)

The % EWL was measured at 3 periods (6, 12 and 36 months). Toparki study is excluded from this result because %EWL was not measured in study.

The %EWL at 6 months was reported in thirteen studies: The mean difference for RCTs was -5.37, 95% CI (-10.02, -0.73) (P=0.02), which favors sleeve with statistically significant difference. While, mean difference for observational studies was -12.43, 95% CI (-16.45, -8.42) (p<0.00001) which favor of sleeve and statistically significant (Figure 2).

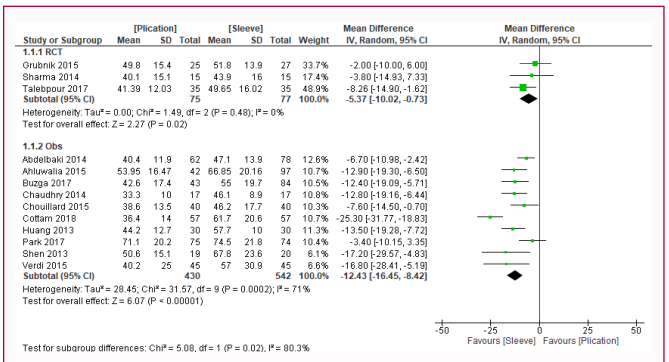

Figure 2: Comparison: Plication *vs.* Sleeve: Excessive weight loss at 6 months.

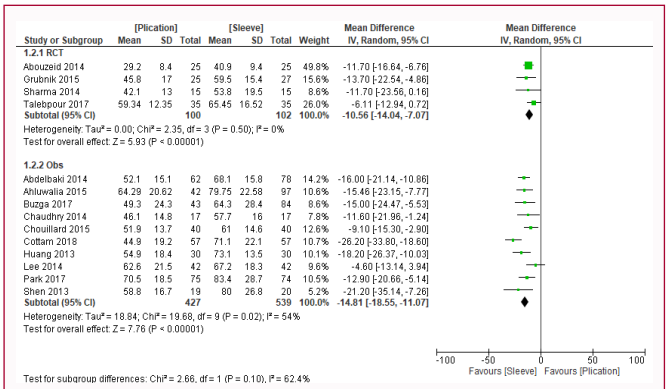

Figure 3: Comparison: Plication *vs.* Sleeve: Excessive weight loss at 12 months.

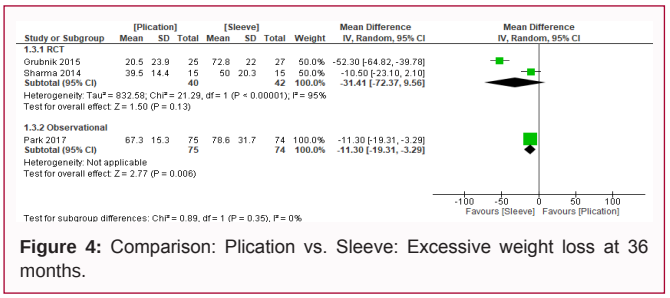

Figure 4: Comparison: Plication vs. Sleeve: Excessive weight loss at 36 months.

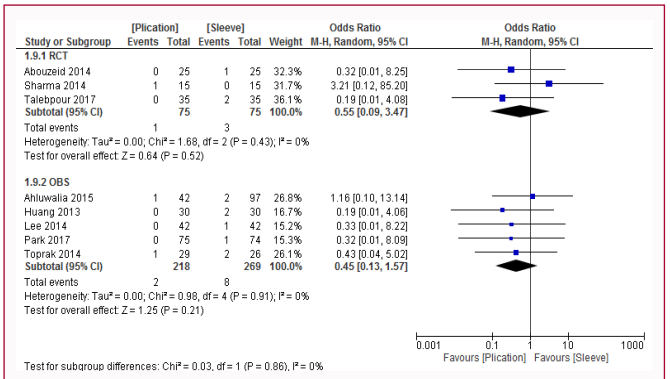

Figure 5: Complication: Leak.

The %EWL at 12 months was reported in fourteen studies (Figure 3); the mean difference for RCTs was -10.56, 95% CI (-14.04, -7.07) which favors of sleeve with a significant difference. Also, the mean difference for observational studies was -14.81, 95% CI (-18.55, -11.07) which favors of sleeve with a significant difference.

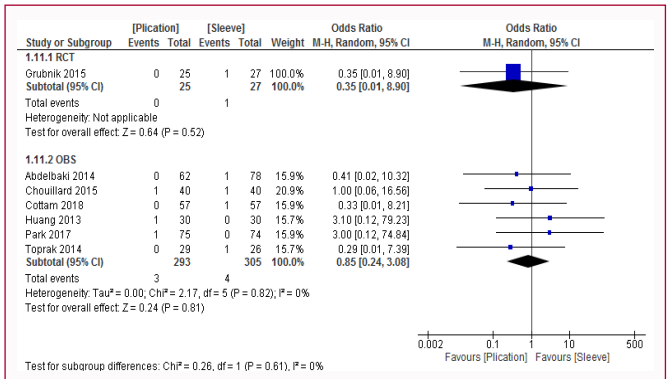

Figure 6: Complication: Bleeding.

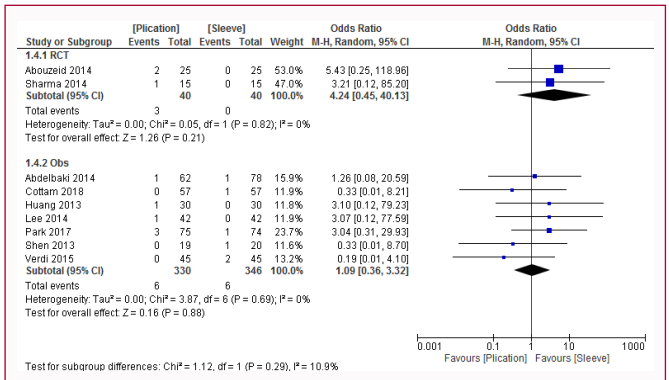

Figure 7: Complication: Obstruction/Stenosis.

AT 36 months (Figure 4) the mean difference for the RCTs was -31.41, 95% CI (-72.37, 9.56) which favors sleeve with no significant difference. Also, the mean difference for observational studies was -11.30, 95% CI (-19.31, -3.29) which favors of sleeve with a significant difference.

Complications

Leak: The OR for 3 RCTs was 0.55, 95% CI (0.09-3.47) with more in sleeve than plication with no significant difference. And same for the observational studies was 0.45, 95% CI (0.13, 1.57) which favors plication, but no significant difference (Figure 5).

Bleeding: There are 7 studies report bleeding, both RCTs and observational subgroups favor plication but no significant difference, the OR for RCTs was 0.35, 95% CI (0.01, 8.90), and for observational studies was 0.85, 95% CI (0.24, 3.08) (Figure 6).

Obstruction and stenosis: Nine studies had obstruction /stenosis outcomes, the OR of RCTs was 4.24, 95% CI (0.45,40,13) favors sleeve but no significant difference, while OR for observational studies was 1.09, 95% CI (0.36, 3.32) with no significant difference (Figure 7).

Nausea and vomiting: Nine studies reported nausea and vomiting, the OR for RCTs was 1.66, 95% CI (0.28, 9.76) which favor of sleeve but no significant difference. While, the OR for observational studies was 2.26, 95% CI (0.89, 5.70) which favors sleeve with a significant difference (Figure 8).

Other complications

- **Reflux:** Five studies reported reflex, the OR for RCTs was 1.08, 95% CI (0.06, 18.30) with no significant difference. While, the OR for observational studies was 0.32, 95% CI (0.09, 1.15) which favors plication with no significant difference (Figure 9).

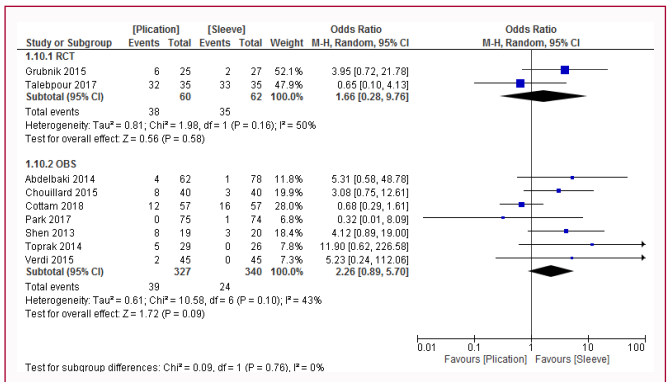

Figure 8: Complication: Nausea and vomiting.

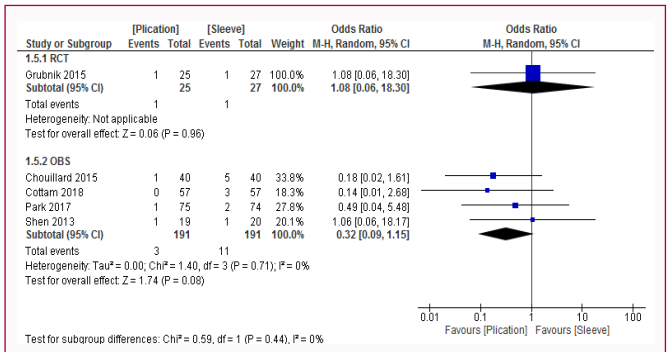

Figure 9: Other complications: Reflex.

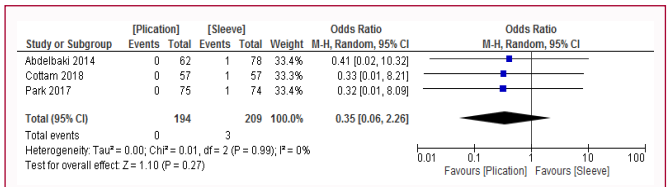

Figure 10: Other complications: Port site hernia.

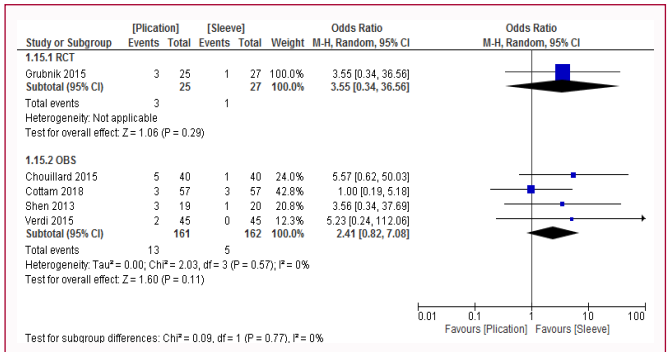

Figure 11: Other complications: Abdominal Pain.

- **Port site herniation:** Three observational studies reported port site herniation, the OR was 0.35, 95% CI (0.06, 2.26) which favors plication with no significant difference (Figure 10).

- **Abdominal pain:** Five studies reported abdominal pain, the OR for RCTs was 3.55, 95% CI (0.34, 36.56) which favors sleeve with no significant difference. While, the OR for observational studies was 2.41, 95% CI (0.82, 7.08) which favors sleeve with no significant difference (Figure 11).

- **Death:** This outcome was only reported in one study the OR was 3.09, 95% CI (0.12, 78.41) which favors sleeve with no significant difference (Figure 12).

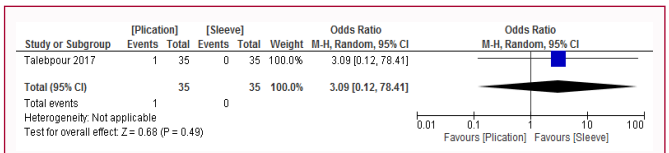

Figure 12: Other complications: Death.

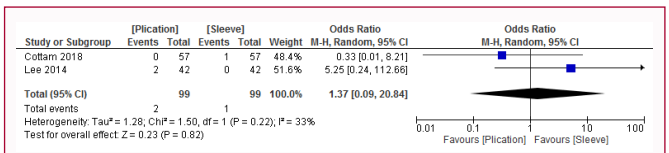

Figure 13: Other complications: Fundus herniation.

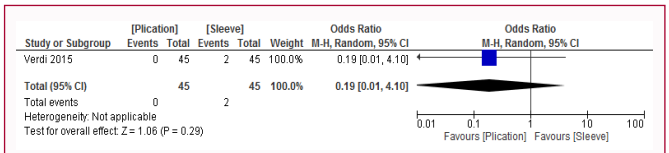

Figure 14: Other complications: Anemia.

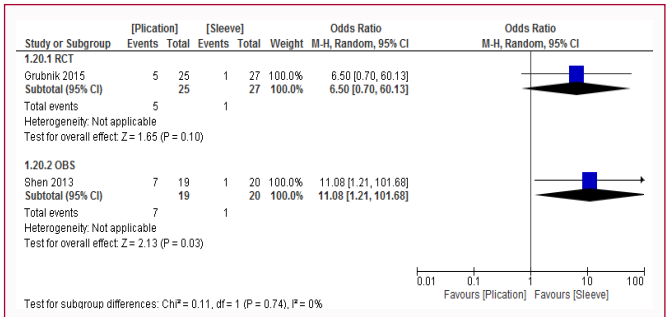

Figure 15: Other complications: Sialorrhea.

- **Fundus herniation:** Two observational studies reported fundus herniation, the OR was 1.37, 95% CI (0.09, 20.84) which presents no significant difference (Figure 13).

- **Anemia:** This outcome was only reported in one study the OR was 0.19, 95% CI (0.01, 4.10) which favors plication with no significant difference (Figure 14).

- **Sialorrhea:** Two studies reported this outcome with one study in RCT and one observational, the OR for the RCT was 6.50, 95% CI (0.70, 60.13) which favors sleeve with no significant difference. While, the OR for observational study was 11.08, 95% CI (1.21, 101.68) which favors sleeve also but with no significant difference (Figure 15).

Re-operation

Reoperation was more in plication than sleeve in RCTs and in observational studies. The OR for RCTs was 2.27, 95% CI (0.44, 11.67) which favors of sleeve but no significant difference. While, the OR of observational studies was 1.73, 95% CI (0.66, 4.59). There is no heterogeneity I^2=0.00% in RCTs but mild heterogeneity I^2=57% (Figure 16).

Hospital course

Operative time: The mean difference of RCTs was -19.00, 95% CI (-28.35, -9.65) which favors Plication with a significant difference.

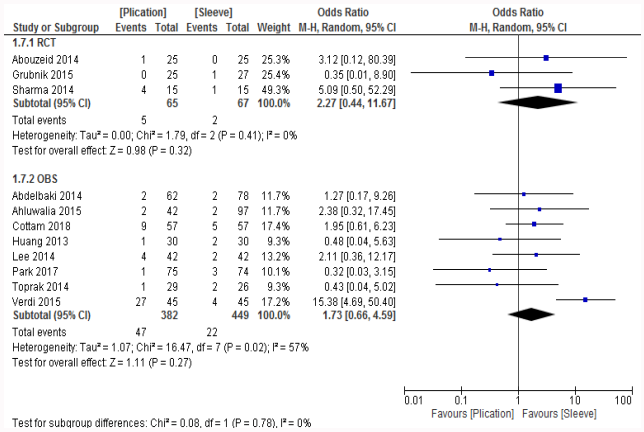

Figure 16: Other complications: Reoperation.

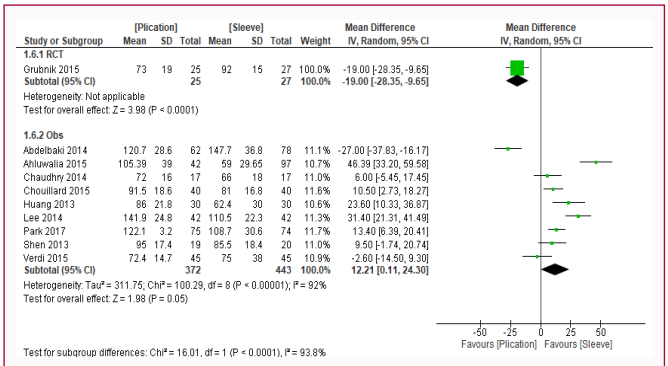

Figure 17: Hospital course: Operation time.

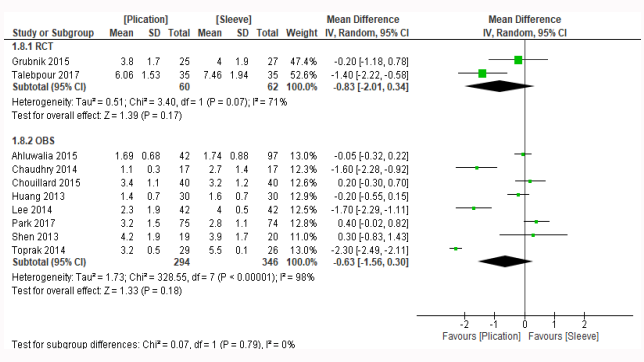

Figure 18: Hospital course: Hospital stay.

While, the mean difference for observational studies was 12.21, 95% CI (0.11, 24.30) which favors sleeve with a significant difference. I^2 is 92% which mean that there was high heterogeneity (Figure 17).

Hospital stay: The mean difference of RCTs was -0.83, 95% CI (-2.01, 0.34) which favor of plication but no significant difference. While, the mean difference of observational studies was -0.63, 95% CI (-1.56, 0.30), which favors of plication but no significant difference (Figure 18). I^2 for observational subgroup is 98% which means a high heterogeneity.

Comorbidity

Hypertension: Eight studies reported hypertension improvement. The OR for RCTs was 0.37, 95% CI (0.06, 2.33) which favors of sleeve with no significant difference. While the OR of observational studies was 0.64, 95% CI (0.24, 1.70) which favor of sleeve also but with no significant difference (Figure 19).

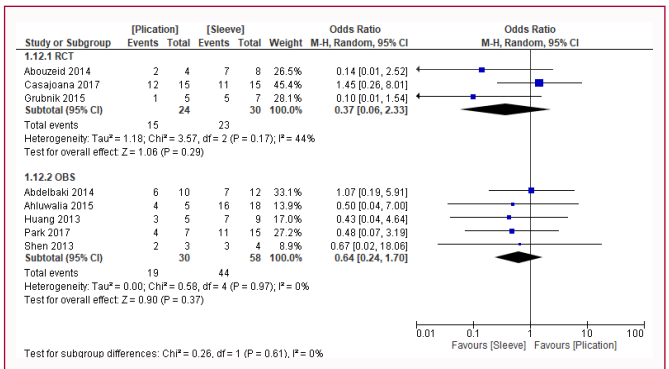

Figure 19: Comorbidity resolution: HTN resolution.

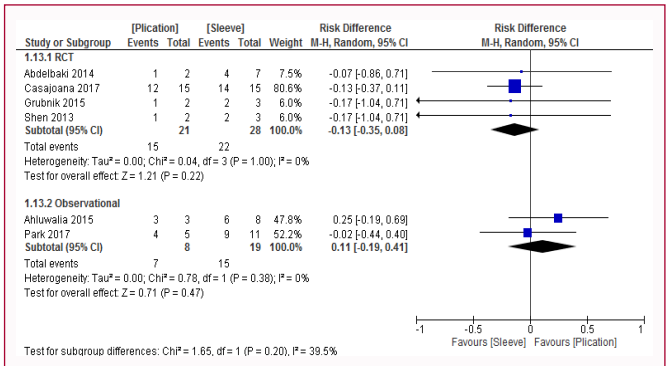

Figure 20: Comorbidity resolution: DM resolution.

Diabetes mellitus: The OR for6 studies report DM improvement was -0.13, 95% CI (-0.35, 0.08), which is in favor of sleeve but with no significant difference. And for observational OR 0.11, 95% CI (-0.19, 0.41) which is in favor of plication but with no significant difference (Figure 20).

Discussion

As the continuous update in bariatric surgery looking for less invasive and less destruction to anatomy procedures Laparoscopic great curvature plication was introduced, plication was introduced to the world at 2007 by Talebpour and Amoli [36,37]. However, the result of this meta-analysis shows that the plication procedure is less effective in terms of weight reduction but comparable in terms of complications with sleeve.

Although, there was no evidence until 2015 when a meta-analysis comparing this procedure with sleeve was published [38], however, that recent published meta-analysis [39], has included only 4 studies [25,26,33,35], with 1 RCT and 3 observations. At 2017 another meta-analysis was published, include 8 studies [23-25,28,30-32,34] with 3 RCT and 5 observations (Figure 21a).

While ours is including 16 studies, with 4 RCTs and 12 observational, that includes all studies referred to other than that, our meta-analysis includes more data especially on complications and co-morbidities improvement, and different pooling of RCT results than observation results (Figure 21b).

However, multiple published reports support the notion of the effectiveness of gastric plication, at 24 months, %EWL ranges from 42,6% to 70% in 4 reports [36,37,40,41], while at 36 months, %EWL ranges from 34,9% to 66% in 3 reports [37,40,41]. However, there is

Figure 21: Quality assessment of the included studies.
a: Randomized control trials. **b:** Observational Studies Quality Assessment.

a study showed that the reduction of weight was limited to the first 6 months than persisted until 12 months, and then continue to reduce [42].

Saying that, one report found that plication procedure is more effective in those with BMI less than 40 kg/m^2 preoperatively. %EWL was 35.9% for patients with leak is less in plication. But higher incidence or morbidity BMI <40 kg/m^2, compared to 30.5% for those with BMI ≥ 40 kg/m^2 at 6 months [42].

Owing to continuous updating of bariatric surgery techniques to reach optimal goals with no complications, the mortality rate is decreasing to lower rates nowadays [43]. In this meta-analysis, there is one mortality case was reported in plication group due to PE in all studies [44].

In Andraos 2011 study of 120 patients, focusing on gastric plication complications occurred for up to six months of follow-up. Early complications were mainly due to obstruction (7.8%), by fold edema of the gastric pouch (5%), or by intramural hematoma. Fortunately, all treated successfully with conservative management, except for one case that needed re-operated [45]. Serious and devastating complications like leakage occurred in 0.7% with more incidences in sleeve, while bleeding occurred in 7 studies with more incidences in plication [46]. However, Nausea and vomiting were the most complications occurred in 25% to 40%, these symptoms disappeared spontaneously in almost cases [42,45,47]. Gastroesophageal reflux incidence is increased in obesity. Sleeve recognized to worsen GER symptoms; sleeve is not advisable in the patient with reflex case of coexistence of GERD [46].

In an Elwan study 2016, Gastroesophageal reflux symptom recurrence is 20% in the sleeve with crurl repair and no recurrence occurred in gastric plication with Nissen fundoplication [48]. However, in this meta-analysis, GERD symptom was encountered in few numbers of cases, none significantly less in plication.

Reoperation for complication or regain weight which is a challenging issue of bariatric surgeries was a focus point in studies. In Fried study, 4 patients out of 244 (0.016%) were re-operated electively by applying additional suture line to address weight loss plateaus [42]. While Verdi represents 27% total cases re-operated for complication and inadequate weight loss [26]. However in our meta-analysis total of reoperation is 52 for plication and 24 for sleeve most of them due to complications (48 plication, 23 sleeve).

Diabetes mellitus type II and hypertensions are obesity-related diseases, their remission and improvement are enhanced by weight reduction. In gastric plication, diabetes was improved up to 92%, and this was correlated significantly with trend of weight loss [40,42,47,49]. While, hypertension was improved from 40% to 80% with plication [47,49].

The implications of this review are quite significant on bariatric surgery. The evidence summarized that plication reduces the weight of morbid obese but less than sleeve, although in general terms a subclass of people with BMI less than 40 kg/m^2 can benefit from plication. Saying that, do we recommend that family physicians, surgeons, internists and endocrinologists advice their patients to do plication procedure? Although, there is a debate about patient specific factors to determine ideal bariatric surgery for each case. Our result does not support the hypothesis of plication is better compared to sleeve and we accept the alternative hypothesis that sleeve is better.

Future studies should be conducting, mainly RCTs, with a large number of participants, many senior and junior surgeon, and follow-up long enough to detect the weight changes and testing co-morbidities improvement on different BMI group, comparing plication with sleeve procedures.

However, several limitations must be taken into consideration in our review. The small sample size with sixteen studies is the main factor. Second, not all enrolled studies are randomized control trials, only 4 studies. Furthermore, 9 studies were retrospective studies, which may cause selection and detection bias (Figure 21). Third, two techniques of plication were involved (banded, non-banded). Finally, many cases withdrawn from studies so, we should interpret the result carefully when making a decision or concluding recommendations.

Conclusion

This systematic review suggests that plication is less effective compared to sleeve in terms of weight reduction, but comparable in terms of complications and hospital course. And unless there is emerging a new promising result, plication procedures should be disparaged.

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