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Laparoscopic Roux-en-Y versus One Anastomosis Gastric Bypass on Remission of Diabetes in Morbid Obesity

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Abstract

Background: Laparoscopic one anastomosis gastric bypass (OAGB) and laparoscopic Roux-en-Y gastric bypass (LRYGB) are common treatments for morbid obese patients who suffer from type 2 diabetes mellitus (T2DM). It has been hypothesized that diabetes may be resolved or improved after bariatric procedures, although the exact effect has not been well established. The present study aimed to compare remission of T2DM after LRYGB versus OAGB in this study.

Methods: All diabetic obese patients, aged between 16 to 60, who referred to Hazrat Rasul Akram obesity clinic from April 2010 to March 2013 for LRYGB or OAGB were included in the present study. Pre-operative parameters, including glycosylated hemoglobin (HbA1c), fasting plasma glucose (FPG), body mass index (BMI), and type of diabetes medication were extracted from database and recorded. Pre-operative and three months postoperative values were then compared between the groups.

Results: Out of 95 eligible patients, 50 patients underwent OAGB and 45 patients had LRYGB. The two groups were homogenous in distribution of gender, mean age, weight, BMI, and FPG; however, mean HbA1C was relatively higher in LRYGB group (P = 0.05) than other group, which was non-significant after adjustment. Rate of remission was significantly higher in OAGB group than other group after three months follow-up (64.0 versus 31.1%, respectively) (P = 0.002).

Conclusions: In our short-term follow-up, OAGB had a higher rate of remission of T2DM compared to LRYGB, which could be due to different baseline value of HbA1c (before surgery) between two groups. Future research is thus suggested with linger follow-up and randomized study design.

Keywords: Gastric Bypass, Roux-en-Y, Diabetes Mellitus,Type2, HbA1c, Obesity, One-Anastomosis Gastric Bypass (OAGB), Mini-Gastric Bypass (MGB)

1. Background

Morbid obesity, associated with a high rate of comorbidities and decreased life expectancy, is defined as body mass index (BMI) greater than 40kg/m^2. Obesity and type 2 diabetes mellitus (T2DM) are the most common chronic diseases in developed and developing countries (1, 2) The prevalence of diabetes and obesity are reported at 7.7% (3) and 21.5% in Iranian population (4). As reported by international diabetes federation, globally 80% of humans suffering from T2DM are obese at diagnosis (5). Asian obese patients experience diabetes in lower BMI values and younger age (6). Therefore, it is critical to pay attention to this matter, especially in Asian countries like Iran.

Medication, diet, and exercise are proven to be the cornerstones of diabetes and obesity treatment. However, the success rate of medical management in long term is discouraging. There is no absolute medical treatment for T2DM; furthermore, some diabetes medications lead to weight gain, which ignites a vicious cycle for the patient (7, 8).

Metabolic procedures offer an alternative for patients with T2DM. Malabsorptive procedures are suggested to have better outcomes than restrictive ones (9, 10). LRYGB, as a mixed procedure (both restrictive and malabsorptive), seems to be a safe treatment for morbid obesity and the

subsidence of related comorbidities, especially T2DM (11). OAGB is reported to be as effective as LRYGB in treatment of morbid obesity (12) with 27% shorter time of operation, and shorter hospital stay (13, 14). Moreover, in patients with central obesity or diabetes, presence of thick and short small bowel mesentery makes LRYGB a difficult procedure; however long gastric tube makes gastrojejunostomy easier in OAGB (15) Re-operation is also much easier, in case of complications, as far as the pouch is longer in OAGB (16).

Diabetes, as one of the most important complications of obesity, is successfully managed with bariatric surgery. A meta-analysis study has concluded that OAGB is effective on weight loss and T2DM remission, but different studies have reported different remission rates and the exact mechanism is still unknown (17). Moreover, the superiority of one technique to another is still controversial; thus, a detailed comparison of two commonly performed techniques onT2DM remission seems valuable to indicate the most proper surgical method for obese patients with T2DM. Therefore, we aimed to compare the remission of T2DM after LRYGB versus OAGB in this study.

2. Methods

The study conducted between April 2010 and March 2013, all morbid obese patients with T2DM, aged between 16 and 60 years, who underwent LRYGB or OAGB at obesity clinic of Hazrat Rasul Akram medical center, Tehran, Iran (approved as center of excellence for metabolic and bariatric surgery by international federation of surgery for obesity and metabolic disorders: IFSO) were recruited into the study. Patients who lacked three months postoperational follow-up were not included in the analysis. Patients were classified into two groups based on the type of the procedure. A comprehensive retrospective chart review was performed by a fellow of laparoscopy (OA). Preoperative parameters such as glycosylated hemoglobin (HbA1c), fasting plasma glucose (FPG), BMI, and type of diabetes medication were extracted from the electronic database of the clinic. Preoperative and three months' postoperative data were compared between LRYGB and OAGB groups.

American diabetes association (ADA) criteria were used to diagnose T2DM based on FPG concentration: impaired fasting glucose (IFG) was considered as FPG 100 - 126 mg/dl, clinical diabetes was defined as FPG $\geq$ 126mg/dl or HbA1c $\geq$ 6.5, which was confirmed by repeated blood sampling, unless the patient has clinical symptoms or glucose level of $\geq$ 200 mg/dl and previous history of diabetes and/or consumption of diabetes medications (5, 18).

Diabetes improvement was defined according to ADA guideline: HbA1c less than 5.7% without diabetes medication was considered as remission and HbA1c 5.7% - 6.5% without diabetes medication as partial remission (19, 20).

For patients who underwent LRYGB, 15 to 20 ml gastric pouch was created. Biliopancreatic limb and enteric limb were measured 50 - 70 and 120 - 150 cm, respectively. For patients who underwent OAGB, 50 ml gastric pouch was created and loop gastrojejunostomy was performed 200 cm from Treitz ligament. We have used Rutledge technique but instead of transverse anastomosis, longitudinal gastrojejunostomy with 4.5 cm blue cartridge on the posterior aspect of the pouch have been implemented.

2.1. Statistical Analysis:

Continuous variables were presented as mean ($\pm$ SD) and qualitative variables were reported through frequencies (percentage). The independent T-Test was utilized to compare mean of continuous outcomes between two groups. Analysis of co variance (ANCOVA) was utilized for comparing mean of postoperative continuous outcomes by adjustment on preoperative data.

Distribution of qualitative variables between two groups was assessed using Chi-square or Fisher exact test. The paired T-Test was used to compare pre-operative and postoperative values within two groups. Statistical analysis was performed using SPSS (Version 20.0. Armonk, NY: IBM Corp). P values less than 0.05 were considered statistically significant.

3. Results

Ninety-five patients who had completed three months' follow-up were included in the final analysis, comprising 50 patients in OAGB group and 45 in LRYGB group. Eighty-three patients (87.4%) were female. The most common co morbidity was hypertension in 12 patients (23.2%). Other co morbidities are illustrated in Table 1. In pre-operational assessment, 49 patients (51.6%) did not use any diabetes medications (Table 1).

The two groups were comparable in terms of age, sex, mean weight, BMI, FBS and percentages of co morbidities, but mean HbA1c was relatively higher in LRYGB group 7.48% compared to 6.77% in OAGB group (P = 0.05) (Table 1).

Both groups had a significant reduction in BMI and FBS levels after three months (all P < 0.001), which was not statistically different between two groups. Mean excess body weight (EWL) after three months was 34.58 (12.55) in LRYGB group and 36.36 (10.91) in OAGB group (P = 0.46). Mean of weight loss (WL) was not also different between two groups after three months (P = 0.24) (Table 2). Mean HbA1c, after three months, was 5.99 (1.29) in LRYGB group versus 5.39 (1.20) in OAGB group, which was significantly different (P =

Table 1. Baseline Characteristics of the LRYGB and OAGB Groups[a]

	LRYGB (n = 45)	OAGB (n = 50)	P Value
Age (year)	45.3 (9.12)	42.8 (9.56)	0.187[b]
Weight (kg)	118.9 (19.11)	119 (15.24)	0.976[b]
BMI (kg/m2)	45 (5.76)	46.2 (5.29)	0.291[b]
LDL (mg/dL)	112.9 (37.60)	108.9 (32.02)	0.596[b]
HDL (mg/dL)	47.4 (13.02)	44.2 (11.21)	0.207[b]
Total Cholesterol (mg/dL)	198.1 (45.76)	191.2 (46.56)	0.482[b]
HbA1c (%)	7.48 (1.55)	6.77 (1.89)	0.050[b]
FBS (mg/dL)	146 (53.990)	136.3 (40.52)	0.317[b]
Gender, No. (%)			0.845[c]
Male	6 (13.3%)	6 (12.0%)	
Female	39 (86.7%)	44 (88.0%)	
Comorbidities, No. (%)			0.444[c]
None	24 (53.3%)	34 (68.0%)	
Sleep apnea	6 (13.3%)	5 (10.0%)	
Hypertension	12 (26.7%)	10 (20.0%)	
Sleep apnea/Hypertension	3 (6.7%)	1 (2.0%)	
Preoperative, No. (%)			0.394[d]
None	22 (48.9%)	27 (54.0)	
Drugs, Glibenclamid	1 (2.2%)	0 (0.0%)	
Metformin	7 (15.6%)	13 (26.0%)	
Glibenclamid/Metformin	11 (24.4%)	7 (14.0%)	
Insulin/Glibenclamid/Metformin	4 (8.9%)	3 (6.0%)	

[a] Values are expressed as mean (SD) unless otherwise indicated
[b] Significances are based on Independent T-Test
[c] Significances are based on Chi-squared test
[d] Fisher-exact

0.02). Because the mean HbA1c was different between two groups pre-operatively, we used analysis of co variance and after adjustment of the preoperative values, there was no significant difference between two groups (P = 0.16) (Table 3).

In three months follow-up, 90.5% of patients did not require any diabetes medication, 7.4% continued oral hypoglycemic agent, and 2.1% needed insulin and oral diabetes medication agent for hyperglycemia control. We have found that the rate of remission of T2DM was 64% in OAGB group and 31.1% in LRYGB and partial remission was 26% and 60%, respectively. Remission was significantly higher in OAGB group than LRYGB group in three months follow-up (P = 0.00) (Table 4). Because of difference in pre-surgical level of HbA1c, we used ordinal logistic regression and considered the value of HbA1c before surgery as a covariate, which showed that the difference was no longer significant on remission of T2DM between OAGB and LRYGB groups (P = 0.127).

4. Discussion

In this study, the differences in percentages of excess weight loss (EWL) between the OAGB and LRYGB were statistically insignificant; this might have been due to the short term follow-up of this study; Thus, although the results are not statistically significant, this difference is of great clinical importance.

In the present study, EWL reduced to 34.58 in LRYGB group and 36.36 in OAGB group after three months (P = 0.46). Previous studies have also reported EWL values for bariatric procedures. Lee et al. reported better EWL at five years in OAGB compared to LRYGB.(13)In Walsh's study, 80% EWL was reported twelve months after the operation (21).

Table 2. Comparison of Excess Weight Loss and Clinical Results between Two Groups Three Months Postoperatively[a]

	LRYGB (n = 45)	OAGB (n = 50)	P Value[b]
BMI, Kg/m^2	37.2 (5.44)[c]	37.5 (4.78)[c]	0.773
FBS, mg/dl	105.3 (18.93)[c]	101.1 (14.35)[c]	0.219
EWL, %	34.58 (12.55)	36.36 (10.91)	0.461
WL, Kg	17.28 (5.90)	18.69 (5.56)	0.243

[a]Values are expressed as mean (SD) unless otherwise indicated
[b]significancies are based on Independent T-Test, P < 0.05
[c]Significant versus preoperative data based on paired T-Test
Abbreviations: BMI, body mass index, dl: deciliter; EWL, Excess Weight Loss; FBS, fasting blood sugar, Kg: kilogram; OAGB, One Anastomosisgastric bypass; LRYGB, laparoscopic Roux-en-Y gastric bypass; m^2, Square meter, mg: milligram; SD, standard deviation; WL, Weight Loss

Table 3. Comparison of HbA1c between Two Groups Three Months Postoperatively[a]

	LRYGB (n = 45)	OAGB (n = 50)	P Value[b] LRYGB versus OAGB
HbA1c (Crude)	5.99 (0.19)	5.39 (0.17)	0.021
HbA1c (Adjusted)	5.83 (0.153)	5.53 (0.145)	0.160

[a]Values are expressed as mean (SE) unless otherwise indicated
[b]Crude significances are based on Independent T-Test. Adjusted significances are based on Analysis of Covariance and adjustment on preoperative value.
Abbreviations: OAGB: One Anastomosisgastric bypass, LRYGB: laparoscopic Roux-en-Y gastric bypass, SE: standard error

Table 4. Comparison of Rate of Remission After Three Months between LRYGB and OAGB Groups[a]

	No Remission No. (%)	Partial Remission No. (%)	Complete Remission No. (%)	P Value
LRYGB (n = 45)	4 (8.9)	27 (60.0)	14 (31.1)	0.002
OAGB (n = 50)	5 (10.0)	13 (26.0)	32 (64.0)	

[a]Significancies are based on Chi-square test
Abbreviations: OAGB: Laparoscopic mini-gastric bypass, LRYGB: laparoscopic Roux-en-Y gastric bypass

However, Kim et al. revealed 9.6% weight loss six months after OAGB for diabetic non-obese patients (22). Different EWL reports might be due to the difference in details of bariatric techniques, patient characteristics, such as underlying diseases like T2DM, as well as different follow-up intervals.

The rate of T2DM remission was significantly higher in our study in OAGB group than LRYGB group in three months' follow-up (64.0% in OAGB versus 31.1% in LRYGB). This result may be due to two reasons: first, saliva enzymes and second, longer bypass limb in OAGB, as the concentration of total protein is higher in the saliva of obese individuals, who had not been subjected to bariatric surgery. There may also be a possible relationship between the salivary proteome and taste sensitivity in obese individuals that can eventually result in different food intakes (23). Moreover, saliva enzymes are not in direct contact with small bowel mucosa and they excrete to about 200 cm away in OAGB compared to direct contact of saliva enzymes after passing the gastric pouch in LRYGB. The anatomic changes in bariatric procedures cause pancreatic enzymes arrive to the gastrointestinal anastomosis more deactivated and less aggressive as more large biliopancreatic limb (24). The enzymatic effect of saliva affects the absorption of carbohydrates and proteins even in the absence of pancreatic enzyme. However, after adjusting HbA1c, diabetes remission was not different between OAGB and LRYGB.

Overall, comparative studies and randomized clinical trials (RCTs) show that OAGB is better than purely restrictive operations and is similar to RYGB in its metabolic benefits. Because in OAGB, the biliopancreatic limb is large, pancreatic enzymes which arrive to the gastro-intestinal anastomosis are more deactivated and less aggressive (24).

Dixon et al. conducted a study on 154 Chinese patients to assess predictors of T2DM remission after MGB and RYGB. They defined remission of diabetes as HbA1c $\leq$ 6 and revealed 69.7% T2DM remission after twelve months of follow-up with OAGB having a higher level of T2DM remission and have reported its reason to be better weight loss in

OAGB and proper patient choice for the procedures (25). Li et al. have conducted a meta-analysis comparing T2DM between LRYGB and laparoscopic sleeve gastrectomy that revealed higher remission rate of T2DM in LRYGB group (26). In Buchwald's review of several methods of weight loss procedures diabetes was controlled in 80% and resolved in 76.8% of patients. The rate of diabetes remission was 98.9% for biliopancreatic diversion with duodenal switch (BPD-DS), 83.7% for gastric bypass, 71.6% for gastroplasty, and 47.9% for gastric banding (27). In a recent review of five studies, comparing LRYGB with OAGB on T2DM remission, OAGB seemed more effective in weight loss (%EWL) and remission of T2DM (93.4% versus 77.6%) than LRYGB (17), which is consistent with the results of the present study. Some other studies have evaluated clinical remission as no need for any diabetes medication after bariatric surgery and found clinical remission in 47 - 80% of patients after restrictive procedures, in 80 - 90% of patients after LRYGB and in 96 - 100% of patients after BPD-DS procedure (28, 29). In 2011, Lee et al. reported 97% diabetes remission in gastric bypass group compared to sleeve gastrectomy group 47% and concluded that improvement in insulin resistance due to exclusion of duodenum induces rapid postoperative remission of diabetes (30). In Hall's experience diabetes remission, defined as HbA1c less than six and no need for any type of anti-diabetic medication, was obtained in 68.4% of obese patients undergoing LRYGB (31). Totally, it could be concluded that diabetes resolution refers to changes in biochemical parameters and reduction or cessation of medication requirements and it coul be derived by the assessment by endocrinologist/physician, responsible for follow-up visits. The most frequently utilized methods for defining T2DM remission are changes to oral hypoglycemic agents or insulin requirements and biochemical measures (32). Due to different definitions of diabetes remission after bariatric surgery in several studies the exact rate of complete and partial remission after LRYGB and OAGB, an accurate comparison requires meta-analysis studies.

Many studies have focused on the reason of better outcomes in malabsorptive procedures than pure restrictive procedures. Rearrangement of small bowel anatomy with more distal food delivery in gastrointestinal bypass in combination with changes in gut hormones have been proposed to improve T2DM in malabsorptive procedures independent of weight loss (31, 33, 34). Extremely rapid T2DM remission after gastric bypass surgery (before significant weight loss) and better improvement of T2DM after LRYGB (compared to pure restrictive operation) will also support this hypothesis (35, 36). The efficacy of OAGB in T2DM patients with obesity is also proposed to be related to decrease in ghrelin levels by excluding gastric fundus and rapid hind gut exposure through bypassing the long proximal intestine in some studies (15).

OAGB, compared to LRYGB, has shorter operation time and hospitalization and less postoperative pain and steeper learning curve. OAGB has less complication in small bowel obstruction, internal herniation is a common complication after LRYGB, but there is no report of internal herniation after loop gastrojejunostomy (13, 14). On the other hand, in patients with central obesity or diabetes, presence of thick and short small bowel mesentery makes LRYGB a difficult procedure; however long gastric tube makes gastrojejunostomy easier in OAGB (15). Reoperation would be much easier, as far as in OAGB the pouch is longer (16). The higher rate of complication in LRYGB including dumping syndrome, obstruction, internal hernias, intussusception, malrotation, bleeding, and stenosis and high level of marginal ulcers might be due to the absence of alimentary limb and the absence of jejuno-jejunal anastomosis (37). Thus, as the new medical term "diabetic surgery" suggests, this procedure can be an option for diabetic patients with a BMI lower than the bariatric cut-off for remission of the diabetes and preventing chronic complications on diabetic patients (38).

In our study we had many missing data (such as dosage of medications) due to the retrospective nature of the study. Regarding the advantages of OAGB compared to LRYGB in diabetic patients and the high prevalence of diabetes and obesity in our country, taking this matter under consideration is of great importance for surgeons and endocrinologists. Three month followed up for patients shows remission of diabetes. But, in Vilarrasa et al. followed-up patients for 4.6 $\pm$ 2.6 years after surgery and mean diabetes duration was 20.0 $\pm$ 10.1 years. They concluded that bariatric surgery in patients with type 1 diabetes mellitus largely provides benefits of insulin requirements and some advantages related to the diabetes complication but have no effect on the glycemic control in the long term. (39) In another study, it was shown that longer duration of diabetes is associated with increasing age. They pointed that shorter duration of diabetes lead to patients with good metabolic response (1.75 $\pm$ 0.69 vs. 8.79 $\pm$ 2.8 years) and chance of complete remission after gastric bypass surgery was more in patients with a diabetes duration $<$ 5 years. (40).

In the present study, we did not evaluate underlying factors, such as duration of diabetes, and medical history that could act as a confounder in the present study. Other limitations of the present study included the effect of possible confounders, such as degree and time of diabetes evolution, kind of medical treatment and degree of C peptide that were not considered in the present study. In addition, the cases were selected non-randomly and not matched,

although most baseline characteristics were similar between groups. But the major problem was the difference in baseline HbA1C between groups. Moreover, three months follow-up might not be sufficient to indicate the true effect of surgery on T2DM remission and longer follow-ups were required.

4.1. Conclusion:

This study mostly focused on effect of OAGB and LRYGB on diabetes remission. OAGB had a higher rate of remission of T2DM compared to LRYGB, but the decrease in HbA1c was not statistically different between the procedures, which was mainly due to different status of HbA1c before surgery between two groups. More extensive work up with longer follow-up is required to approve the efficacy of these two procedures on randomized matched patients.

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Footnotes

Authors' Contribution: Contribution to the study: Ommolbanin Abed, Ali Kabir, Abdolreza Pazouki, Peyman Alibeigi, Mohammadreza Abdolhosseini, Fahimeh Soheilipour; Designing the research: Ommolbanin Abed, Ali Kabir, Abdolreza Pazouki, Leila Janani, Fahimeh Soheilipour, Fatemeh Jesmi; Performing the research: Ommolbanin Abed, Abdolreza Pazouki, Peyman Alibeigi, Mohammadreza Abdolhosseini; Contribution new regions/analytic tools: Ali Kabir, Fahimeh Soheilipour; Analyzing the data: Leila Janani, Ali Kabir; Writing the paper: Ommolbanin Abed, Fatemeh Jesmi, Abdolreza Pazouki, Ali Kabir, Leila Janani

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