

Supplemental Online Content

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eMethods. Additional detailed statistical methods outside article statistical methods and statistical analysis plan

eTable 1. Baseline characteristics

eTable 2. Weight after LSG and LRYGB from baseline to 10 years of follow-up

eTable 3. Detailed GERD-HRQL comparison between LSG and LRYGB at 10 years (No./total (%))

eTable 4. Improvement in glycemic control in patients with diabetes after LSG and LRYGB from baseline to 10 years of follow-up

eTable 5. Lipid profiles for the whole study group after LSG and LRYGB from baseline to 10 years of follow-up

This supplemental material has been provided by the authors to give readers additional information about their work.

eMethods

Additional detailed statistical methods outside article statistical methods and statistical analysis plan

Continuous variables were characterized with means and standards deviations (SD) or medians and minimum and maximum (min – max) of values, and categorical variables with counts and percentages.

For %EWL we used MIXED procedure in SAS to fit a linear mixed model for repeated measures. Excess weight at baseline, operation type, categorical time (within factor) and the interaction of operation and time were included in the model as well as diabetes status and study site as between factors. Additional %EWL analysis was performed for patients with type 2 diabetes.

Linear mixed models suitable for repeated measures were also used for BMI, percentage excess BMI loss (%EBMIL), percentage total weight loss (%TWL), weight, fasting plasma glucose, glycated hemoglobin, total cholesterol, LDL-C, HDL-C, triglycerides, and Moorehead-Ardelt QOL total score. All of the models included operation, categorical time (within factor), the interaction of operation and time, and study site as between factors. Models related to weight loss (%EBMIL, %TWL) also included baseline variables (baseline BMI or weight) as a covariate, and analyses of all variables related to weight and lipids included diabetes status as a between factor. Analyses of fasting plasma glucose and glycated hemoglobin were performed only for patients with diabetes at baseline and preoperative insulin use was also used as between factor in the models. All between factors were fixed effects in the models. Results were quantified using model-based mean estimates with 95% CI. The results are presented separately for both operations and time points only when the interaction term in the model was statistically significant. Otherwise, the estimates of the main effects of operation and time were used.

eTable 1. Baseline characteristics		
	LSG (n=121)	LRYGB (n=119)
Female No. (%)	87 (71.9)	80 (67.2)
Male No. (%)	34 (28.1)	39 (32.8)
Age (years), mean (SD)	48.5 (9.6)	48.4 (9.3)
Weight (kg), mean (SD)	130.1 (21.5)	134.9 (22.5)
BMI (kg/m ²), mean (SD) ^a	45.5 (6.2)	46.4 (5.9)
T2DM No. (%)	52 (43.0)	49 (41.2)
Hypertension No. (%)	83 (68.6)	87 (73.1)
Dyslipidemia No. (%)	39 (32.2)	45 (37.8)
Moorehead-Ardelt QOL total score ^b , mean (SD)	0.10 (0.94)	0.12 (1.12)
Hospitals participating in the study		
Turku (n)	40	40
Vaasa (n)	40	40
Helsinki (n)	41	39
Abbreviations: BMI, Body mass index; T2DM, Type 2 diabetes mellitus; QOL, Quality of life		
^a Calculated as weight in kilograms divided by height in meters squared.		
^b Score range -3 to +3 with higher score indicating better QOL.		

eTable 2. Weight after LSG an LRYGB from baseline to 10 years of follow-up

	Time	LSG, mean estimate (95% CI)	LRYGB, mean estimate (95% CI)	Difference (LRYGB vs. LSG), (95% CI)	P Value	
Weight (kg) ^{a,b,c}	Baseline	135.3	141.0			
		(131.5 to 139.1)	(137.1 to 144.8)			
		n=121	n=119			
	0.5 y	102.5	102.7	0.2	.94	
		(98.7 to 106.3)	(98.8 to 106.6)	(-5.2 to 5.6)		
		n=119	n=111			
	1 y	98.6	97.7	-0.9	.74	
		(94.8 to 102.5)	(93.8 to 101.6)	(-6.4 to 4.5)		
		n=111	n=108			
	3 y	101.1	99.0	-2.1	.46	
		(97.2 to 104.9)	(95.0 to 102.9)	(-7.6 to 3.4)		
		n=108	n=100			
	5 y	104.5	103.2	-1.3	.64	
		(100.6 to 108.5)	(99.2 to 107.2)	(-6.9 to 4.2)		
		n=98	n=95			
	7 y	106.2	104.2	-2.0	.48	
		(102.3 to 110.2)	(100.2 to 108.2)	(-7.6 to 3.6)		
		n=91	n=91			
	10 y	108.1	106.1	-2.0	.47	
		(104.2 to 112.0)	(102.1 to 110.1)	(-7.6 to 3.5)		
		n=98	n=95			
	Abbreviations: %TWL, total weight loss (%) = (initial weight - follow-up weight) : (initial weight) x100%					
	LSG, laparoscopic sleeve gastrectomy; LRYGB, laparoscopic Roux-en-Y gastric bypass					
	^a Superiority design was used in the analysis					
^b Repeated measurements ANOVA (analysis of variance)						
^c p<.001 for operation x time interaction						

eTable 3. Detailed GERD-HRQL comparison between LSG and LRYGB at 10 years (No./total (%))

		LSG	LRYGB	P value
Do you take PPIs?	Yes	61/96 (64)	25/89 (28)	<.001 ^a
	No	35/96 (37)	64/89 (72)	
1. How bad is the heartburn?	0 (No symptom)	31/97 (32)	59/88 (67)	<.001 ^b
	1 (Symptoms noticeable but not bothersome)	21/97 (22)	17/88 (19)	
	2 (Symptoms noticeable and bothersome but not every day)	28/97 (29)	7/88 (8)	
	3 (Symptoms bothersome every day)	9/97 (9)	3/88 (3)	
	4 (Symptoms affect daily activity)	5/97 (5)	2/88 (2)	
	5 (Symptoms are incapacitating to do daily activities)	3/97 (3)	0/88 (0)	
2. Heartburn when lying down?	0 (No symptom)	38/93 (41)	63/87 (72)	<.001 ^b
	1 (Symptoms noticeable but not bothersome)	14/93 (15)	13/87 (15)	
	2 (Symptoms noticeable and bothersome but not every day)	27/93 (29)	6/87 (7)	
	3 (Symptoms bothersome every day)	7/93 (8)	2/87 (2)	
	4 (Symptoms affect daily activity)	2/93 (2)	1/87 (1)	
	5 (Symptoms are incapacitating to do daily activities)	5/93 (5)	2/87 (2)	
3. Heartburn when standing up?	0 (No symptom)	45/96 (47)	69/87 (79)	<.001 ^b
	1 (Symptoms noticeable but not bothersome)	22/96 (23)	8/87 (9)	
	2 (Symptoms noticeable and bothersome but not every day)	18/96 (19)	9/87 (10)	
	3 (Symptoms bothersome every day)	6/96 (6)	0/87 (0)	
	4 (Symptoms affect daily activity)	4/96 (4)	1/87 (1)	
	5 (Symptoms are incapacitating to do daily activities)	1/96 (1)	0/87 (0)	
4. Heartburn after meals?	0 (No symptom)	38/96 (40)	65/88 (74)	<.001 ^b
	1 (Symptoms noticeable but not bothersome)	24/96 (25)	12/88 (14)	
	2 (Symptoms noticeable and bothersome but not every day)	20/96 (21)	6/88 (7)	
	3 (Symptoms bothersome every day)	6/96 (6)	2/88 (2)	
	4 (Symptoms affect daily activity)	6/96 (6)	2/88 (2)	
	5 (Symptoms are incapacitating to do daily activities)	2/96 (2)	1/88 (1)	

		LSG	LRYGB	P value
5. Does heartburn change your diet?	0 (No symptom)	46/90 (51)	69/85 (81)	<.001 ^b
	1 (Symptoms noticeable but not bothersome)	12/90 (13)	9/85 (11)	
	2 (Symptoms noticeable and bothersome but not every day)	14/90 (16)	2/85 (2)	
	3 (Symptoms bothersome every day)	10/90 (11)	0/85 (0)	
	4 (Symptoms affect daily activity)	3/90 (3)	3/85 (4)	
	5 (Symptoms are incapacitating to do daily activities)	5/90 (6)	2/85 (2)	
6. Does heartburn wake you from sleep?	0 (No symptom)	56/93 (60)	73/87 (84)	.010 ^b
	1 (Symptoms noticeable but not bothersome)	9/93 (10)	6/87 (7)	
	2 (Symptoms noticeable and bothersome but not every day)	13/93 (14)	5/87 (6)	
	3 (Symptoms bothersome every day)	7/93 (8)	1/87 (1)	
	4 (Symptoms affect daily activity)	5/93 (5)	1/87 (1)	
	5 (Symptoms are incapacitating to do daily activities)	3/93 (3)	1/87 (1)	
7. Do you have difficulty swallowing?	0 (No symptom)	79/95 (83)	70/87 (81)	.39 ^b
	1 (Symptoms noticeable but not bothersome)	7/95 (7)	11/87 (13)	
	2 (Symptoms noticeable and bothersome but not every day)	6/95 (6)	3/87 (4)	
	3 (Symptoms bothersome every day)	2/95 (2)	1/87 (1)	
	4 (Symptoms affect daily activity)	0/95 (0)	2/87 (2)	
	5 (Symptoms are incapacitating to do daily activities)	1/95 (1)	0/87 (0)	
8. Do you have pain with swallowing?	0 (No symptom)	83/95 (87)	83/87 (95)	.10 ^b
	1 (Symptoms noticeable but not bothersome)	8/95 (8)	3/87 (4)	
	2 (Symptoms noticeable and bothersome but not every day)	3/95 (3)	0/87 (0)	
	3 (Symptoms bothersome every day)	1/95 (1)	0/87 (0)	
	4 (Symptoms affect daily activity)	0/95 (0)	1/87 (1)	
	5 (Symptoms are incapacitating to do daily activities)	0/95 (0)	0/87 (0)	
9. If you take medication, does this affect your daily life?	0 (No symptom)	73/89 (82)	80/83 (96)	.006 ^b
	1 (Symptoms noticeable but not bothersome)	8/89 (9)	0/83 (0)	
	2 (Symptoms noticeable and bothersome but not every day)	3/89 (3)	2/83 (2)	
	3 (Symptoms bothersome every day)	1/89 (1)	1/83 (1)	
	4 (Symptoms affect daily activity)	2/89 (2)	0/83 (0)	
	5 (Symptoms are incapacitating to do daily activities)	2/89 (2)	0/83 (0)	

		LSG	LRYGB	P value
10. How bad is the regurgitation?	0 (No symptom)	44/95 (46)	64/86 (74)	.004 ^b
	1 (Symptoms noticeable but not bothersome)	23/95 (24)	10/86 (12)	
	2 (Symptoms noticeable and bothersome but not every day)	17/95 (18)	6/86 (7)	
	3 (Symptoms bothersome every day)	6/95 (6)	3/86 (4)	
	4 (Symptoms affect daily activity)	2/95 (2)	2/86 (2)	
	5 (Symptoms are incapacitating to do daily activities)	3/95 (3)	1/86 (1)	
11. Regurgitation when lying down?	0 (No symptom)	43/94 (46)	67/85 (79)	<.001 ^b
	1 (Symptoms noticeable but not bothersome)	21/94 (22)	10/85 (12)	
	2 (Symptoms noticeable and bothersome but not every day)	19/94 (20)	1/85 (1)	
	3 (Symptoms bothersome every day)	6/94 (6)	2/85 (2)	
	4 (Symptoms affect daily activity)	3/94 (3)	3/85 (4)	
	5 (Symptoms are incapacitating to do daily activities)	2/94 (2)	2/85 (2)	
12. Regurgitation when standing up?	0 (No symptom)	66/95 (70)	70/85 (82)	.12 ^b
	1 (Symptoms noticeable but not bothersome)	20/95 (21)	10/85 (12)	
	2 (Symptoms noticeable and bothersome but not every day)	8/95 (8)	3/85 (4)	
	3 (Symptoms bothersome every day)	0/95 (0)	1/85 (1)	
	4 (Symptoms affect daily activity)	1/95 (1)	1/85 (1)	
	5 (Symptoms are incapacitating to do daily activities)	0/95 (0)	0/85 (0)	
13. Regurgitation after meals?	0 (No symptom)	52/95 (55)	62/85 (73)	.02 ^b
	1 (Symptoms noticeable but not bothersome)	20/95 (21)	12/85 (14)	
	2 (Symptoms noticeable and bothersome but not every day)	18/95 (19)	6/85 (7)	
	3 (Symptoms bothersome every day)	4/95 (4)	1/85 (1)	
	4 (Symptoms affect daily activity)	1/95 (1)	3/85 (4)	
	5 (Symptoms are incapacitating to do daily activities)	0/95 (0)	1/85 (1)	
14. Does regurgitation change your diet?	0 (No symptom)	57/90 (63)	73/84 (87)	<.001 ^b
	1 (Symptoms noticeable but not bothersome)	16/90 (18)	2/84 (2)	
	2 (Symptoms noticeable and bothersome but not every day)	10/90 (11)	2/84 (2)	
	3 (Symptoms bothersome every day)	4/90 (4)	3/84 (4)	
	4 (Symptoms affect daily activity)	0/90 (0)	1/84 (1)	
	5 (Symptoms are incapacitating to do daily activities)	3/90 (3)	3/84 (4)	

		LSG	LRYGB	P value
15. Does regurgitation wake you from sleep?	0 (No symptom)	60/93 (65)	76/82 (93)	<.001 ^b
	1 (Symptoms noticeable but not bothersome)	7/93 (8)	2/82 (2)	
	2 (Symptoms noticeable and bothersome but not every day)	17/93 (18)	1/82 (1)	
	3 (Symptoms bothersome every day)	2/93 (2)	1/82 (1)	
	4 (Symptoms affect daily activity)	3/93 (3)	0/82 (0)	
	5 (Symptoms are incapacitating to do daily activities)	4/93 (4)	2/82 (2)	
16. How satisfied are you with your present condition?	Satisfied	44/96 (46)	33/90 (37)	.45 ^a
	Neutral	38/96 (40)	42/90 (47)	
	Dissatisfied	14/96 (15)	15/90 (17)	
LSG, laparoscopic sleeve gastrectomy; LRYGB, laparoscopic Roux-en-Y gastric bypass; PPI, proton pump inhibitor				
^a Chi-squared -test				
^b Fisher's exact test				

eTable 4. Improvement in glycemic control in patients with diabetes after LSG and LRYGB from baseline to 10 years of follow-up

	Time		LSG	LRYGB	P Value
Fasting glucose, mmol/l ^{a,b}		Mean estimate	6.9	6.8	.42
		(95% CI)	(6.6 to 7.3)	(6.4 to 7.1)	
Glycated hemoglobin, % ^{a,c}	Baseline	Mean estimate	7.0	7.3	
		(95% CI)	(6.8 to 7.2)	(7.1 to 7.6)	
		No.	52	49	
	0.5 y	Mean estimate	6.4	6.3	.26
		(95% CI)	(6.2 to 6.6)	(6.1 to 6.5)	
		No.	50	43	
	1 y	Mean estimate	6.3	6.2	.47
		(95% CI)	(6.1 to 6.5)	(6.0 to 6.4)	
		No.	50	43	
	3 y	Mean estimate	6.4	6.5	.57
		(95% CI)	(6.1 to 6.6)	(6.2 to 6.7)	
		No.	46	43	
5 y	Mean estimate	6.8	6.6	.23	
	(95% CI)	(6.5 to 7.2)	(6.3 to 6.9)		
	No.	41	40		
7 y	Mean estimate	6.8	6.8	.99	
	(95% CI)	(6.4 to 7.2)	(6.4 to 7.2)		
	No.	39	39		
10 y	Mean estimate	6.9	7.0	.64	
	(95% CI)	(6.6 to 7.2)	(6.7 to 7.4)		
	No.	41	38		
Glycemic status, No./total (%)	0.5 y	T2DM remission ^d	20/50 (40)	22/44 (50)	.41
		No remission	30/50 (60)	22/44 (50)	
	1 y	T2DM remission ^d	22/50 (44)	23/43 (53)	.41
		No remission	28/50 (56)	20/43 (47)	
	3 y	T2DM remission ^d	21/46 (46)	21/42 (50)	.83
		No remission	25/46 (54)	21/42 (50)	
	5 y	T2DM remission ^d	16/41 (39)	21/41 (51)	.37
		No remission	25/41 (61)	20/41 (49)	
	7 y	T2DM remission ^d	12/37 (32)	17/38 (45)	.35
		No remission	25/37 (68)	21/38 (55)	
	10 y	T2DM remission ^d	11/42 (26)	13/39 (33)	.63
		No remission	31/42 (74)	26/39 (67)	

Abbreviations: ANOVA, analysis of variance; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; LSG, laparoscopic sleeve gastrectomy; LRYGB, laparoscopic Roux-en-Y gastric bypass

SI conversion factor: To convert glucose values to mg/dL, divide by 0.0555.

^a Repeated-measurements ANOVA; logarithmic transformation was used in the analyses, and results are transformed back to original scale. Results are adjusted for center and preoperative use of insulin.

^b p=.07 for operation x time interaction, p=.42 for main effect of operation and p<.001 for main effect of time

^c p=.02 for operation x time interaction

^d The new consensus of American Diabetes Association; a return of HbA1c to <6.5% (<48 mmol/mol) that occurs spontaneously or following an intervention and that persists for at least 3 months in the absence of usual glucose-lowering pharmacotherapy

eTable 5. Lipid profiles for the whole study group after LSG and LRYGB from baseline to 10 years of follow-up^{a,b}

	Time	LSG, mean estimate (95% CI)	LRYGB, mean estimate (95% CI)	Difference (LSG vs. LRYGB), (95% CI)	P Value
Total Cholesterol, mmol/l^c	Baseline	4.5	4.6		
		(4.4 to 4.7)	(4.4 to 4.8)		
		n=106	n=106		
	0.5 y	4.5	4.2	0.3	.005
		(4.3 to 4.7)	(4.0 to 4.3)	(0.1 to 0.6)	
		n=115	n=107		
	1 y	4.7	4.3	0.4	.002
		(4.5 to 4.8)	(4.1 to 4.5)	(0.1 to 0.6)	
		n=110	n=105		
	3 y	4.9	4.5	0.4	<.001
		(4.8 to 5.1)	(4.4 to 4.7)	(0.2 to 0.7)	
		n=108	n=100		
5 y	4.9	4.6	0.2	.048	
	(4.7 to 5.0)	(4.5 to 4.8)	(0.003 to 0.5)		
	n=97	n=91			
7 y	4.8	4.7	0.2	.22	
	(4.7 to 5.0)	(4.5 to 4.8)	(-0.09 to 0.4)		
	n=91	n=90			
10 y	4.5	4.5	0.0	.99	
	(4.3 to 4.7)	(4.3 to 4.7)	(-0.3 to 0.3)		
	n=96	n=86			
LDL-C, mmol/l^d	Baseline	2.6	2.6		
		(2.4 to 2.8)	(2.4 to 2.7)		
		n=101	n=103		
	0.5 y	2.6	2.3	0.3	.002
		(2.5 to 2.8)	(2.1 to 2.4)	(0.1 to 0.5)	
		n=111	n=107		
	1 y	2.6	2.3	0.4	<.001
		(2.5 to 2.8)	(2.2 to 2.4)	(0.2 to 0.5)	
		n=109	n=104		
	3 y	2.8	2.4	0.4	<.001
		(2.7 to 2.9)	(2.3 to 2.5)	(0.2 to 0.6)	
		n=107	n=100		
5 y	2.7	2.5	0.3)	.014	
	(2.6 to 2.9)	(2.3 to 2.6)	(0.05 to 0.5)		
	n=95	n=91			
7 y	2.7	2.5	0.2	.07	
	(2.6 to 2.9)	(2.4 to 2.7)	(-0.02 to 0.4)		
	n=91	n=90			
10 y	2.4	2.3	0.1	.50	
	(2.3 to 2.5)	(2.2 to 2.5)	(-0.1 to 0.3)		
	n=96	n=86			

		LSG, mean estimate (95% CI)	LRYGB, mean estimate (95% CI)		P Value
HDL-C, mmol/l ^{e,f}		1.4	1.4		.43
		(1.3 to 1.4)	(1.4 to 1.5)		
Triglycerides, mmol/l ^{e,g}		1.3	1.2		.19
		(1.2 to 1.3)	(1.1 to 1.3)		
Abbreviations: ANOVA, analysis of variance; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; LSG, laparoscopic sleeve gastrectomy; LRYGB, laparoscopic Roux-en-Y gastric bypass					
SI conversion factors: To convert total cholesterol, LDL-C, and HDL-C values to mg/dL, divide by 0.0259; triglyceride values to mg/dL, divide by 0.0113.					
^a All results adjusted for center and diabetes status					
^b Repeated-measurements ANOVA					
^c p=.004 for operation x time interaction					
^d p=.02 for operation x time interaction					
^e Logarithmic transformation was used in the analyses, and results are transformed back to original scale					
^f p=.15 for operation x time interaction, p=.43 for main effect of operation and p<.001 for main effect of time					
^g p=.37 for operation x time interaction, p=.19 for main effect of operation and p<.001 for main effect of time					