Outcomes of bariatric/metabolic surgery for morbidly obese adolescents: a multicenter study in Korea

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SOS, FreeDOM!
Severance Obesity & diabetes Surgery, where you get Freed from Diabetes, Obesity, and Metabolic disorders!

Background

Children & adolescent obesity

2000s

Worldwide 14%
Korea 8.9%

2017

7.9% of obese children &
70% of severely obese children

Worldwide 17%
Korea 12% (class II, 5.2%)

Ha KH, Kim DJ. Epidemiology of Childhood Obesity in Korea Endocrinol Metab 2016;31:510-8

Severely Obese adult

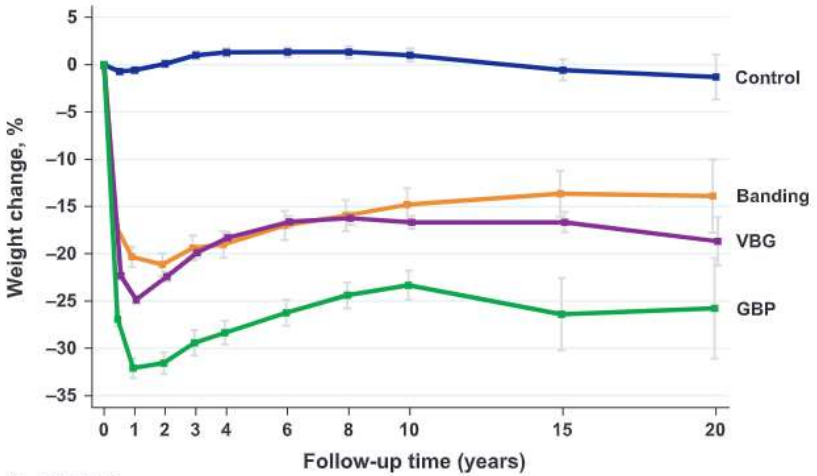
lewellyn, A.; Simmonds, M.; Owen, C.G.; Woolacott, N. Childhood obesity as a predictor of morbidity in adulthood: Asystematic review and meta-analysis. Obes. Rev 2016 ;17, 56–67

		Obesity related diseases
Cardiovascular diseases		Hypertension Stroke Congestive heart failure Pulmonary embolism Ischaemic heart disease
Other diseases	T2DM	Type 2 Diabetes Mellitus Asthma Arthritis Osteoporosis Cholecystitis
	HTN	Dyslipidemia Chronic back pain Emergency caesarean section Preterm labour Hypertensive disorders in pregnancy
	Dyslipidemia	Antepartum hemorrhage Obstructed labour Birth injury
Cancer	NAFLD	Breast Colon Endometrium Esophagus Kidney
	PCOS	Ovary Pancreas Prostate Cervix Leukemia Gallbladder

Stevens J, Cai J, Pamuk ER, et al. The Effect of Age on the Association between Body-Mass Index and Mortality. NEJM 1998;338(1):1-7

Background

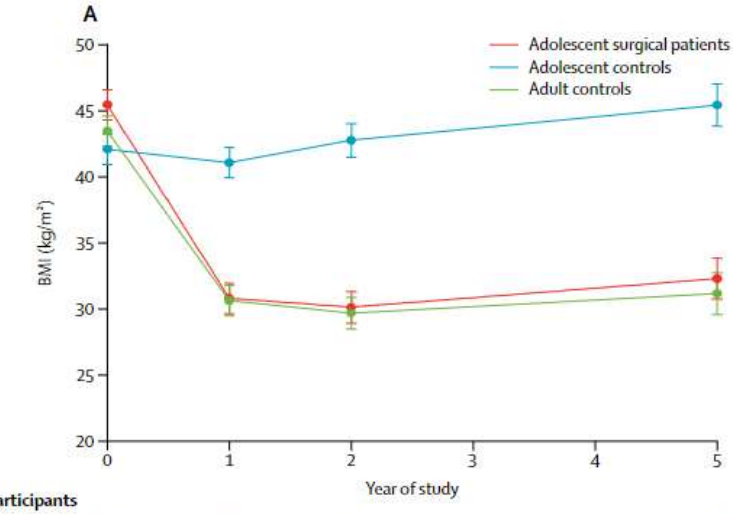
SOS trial, 2012



No. examined

Control	2037	1490	1242	1267	556	176
Banding	376	333	284	284	150	50
VBG	1369	1086	987	1007	489	82
GBP	265	209	184	180	37	13

AMOS, 2017



Number of participants

Adolescent surgical patients	81	81	81	..	..	81
Adolescent controls	80	80	59	..	..	72
Adult controls	81	81	81	..	..	71

Asian study, 2014 & 2018


Original Article

Clinical Experience of Weight Loss Surgery in Morbidly Obese Korean Adolescents

Ji Yeon Park, Dan Song, and Yong Jin Kim

Original Article

Laparoscopic sleeve gastrectomy for morbidly obese adolescents in Singapore

- Most effective solution
- **Comparable and sustained WT loss & comorbidities resolution in adolescents**
- **Longer-term results of adolescent bariatric surgery: yet to be reported in Asian population**

Purpose

- Primary goal: WT 1, 2, 3, 5yrs after bariatric/metabolic surgery in Korean adolescents.

- Secondary goals:

  1) Resolution of comorbidities.
     (Prediabetes & T2DM, HTN, FL, and Dyslipidemia)

  2) <30-day complications, Nutritional deficiencies.

Methods

- The KSMBS bariatric surgery registry (KSMBS research fund #KSMBS-2023-01).
  Jan 2003 – Jun 2021, Age below 19.
  Relevant data using the 6 institutions' EMR.

- Indications:
  BMI > 35kg/m^2 or > 30kg/m^2 with obesity-related comorbidities (T2DM, HTN, FL, Dyslipidemia, etc.)

- Conventional Laparoscopic (or Robotic) Roux-en-Y gastric bypass (RYGB) or Sleeve gastrectomy (SG).

- Exclusion: genetic background, Uncontrolled psychiatric disorder.

Methods

Baseline characteristics

Demographics
- Birth date
- Sex
- Body weight
- Height
- BMI
- Waist circumferance
- Duration of obesity

Personal / Familial factor
- Bone maturity
- Puberty
- Obese parents

Psychosocial factor
- Self body image
- Psychiatric disease
- Eating disorder
- Drug addiction
- Smoking
- Alcohol consumption
- Suicidal attempts

Glucose control status
- Diabetes status
- Duration
- Oral hypoglycemic agent usage
- Insulin usage
- FBG, peak Glc level
- Insulin (fasting/stimulated)
- C-peptide (fasting/stimulated)
- Anti-GAD antibody

Cardiovascular disease
- Blood pressure
- HTN medication
- Total cholesterol
- LDL, HDL, TG
- Dyslipidemia med.

Liver & Renal function
- SGPT, SGOT
- NAFLD, NASH
- Serum creatinine
- Proteinuria
- Glycosuria

Comorbidities
- Obstructive sleep apnea
- Gastroesophageal reflux
- Arthropathy

Nutritional status
- Anemia history
- Fe supplementation
- Hb, MCV
- Serum iron
- Ferritin
- Transferrin
- Calcium
- Vitamin D
- PTH
- Folate
- Vitamin B1
- Albumin

Data collection

Perioperative factor

- Operation
  - Purpose
    Operation type
    Operation time
    Total anesthesia time
  - Bougie size
  - Length of alimentary /biliopancreatic limb
- Complications
  - Mortality
    Cause of death
  - Clavien dindo class.
    Hospital stay

Follow up data

- 1Mon.
- 3Mon.
- 6Mon.
- 12Mon.
- 36Mon.
- 60Mon.
- 120 Mon.
- ~120 Mon.

Obesity profile
- Body weight
  Height
  BMI
  Waist circumferance

Diabetes
- Diabetes status
- FBG, peak Glc level
  Insulin (fasting/stimulated)
  C-peptide (fasting/stimulated)

Cardiovascular disease
- Blood pressure
  HTN medication

Dyslipidemia
- Total cholesterol
  LDL, HDL, TG
  Dyslipidemia med.

Steatohepatitis
- SGPT, SGOT
  NAFLD, NASH

Renal function
- Serum creatinine
  Proteinuria
  Glycosuria

Anemia
- Anemia history
  Fe supplementation
- Hb, MCV
  Serum iron
  Ferritin
  Transferrin

Calcium & Bone metabolism
- Calcium
  Vitamin D
  PTH

Micro & macro Nutrient def.
- Folate
  Vitamin B1
  Albumin

Other comorbidities
- Obstructive sleep apnea
  Gastroesophageal reflux
  Arthropathy

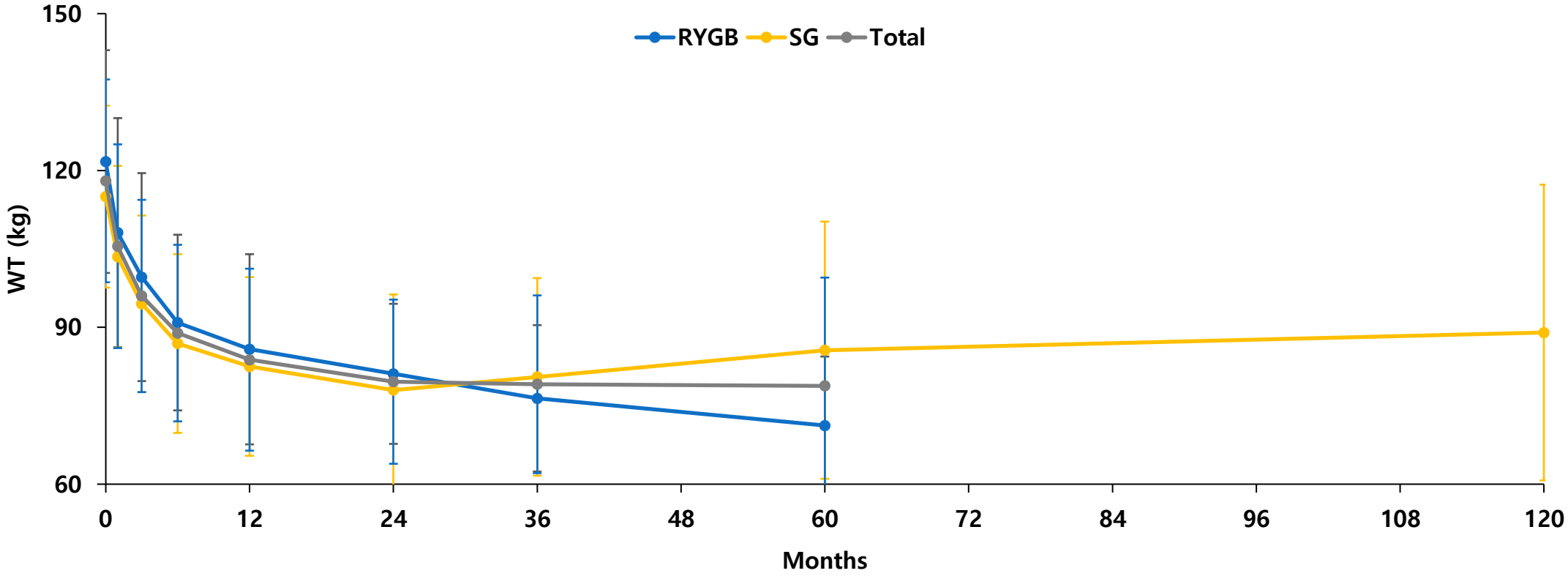
Result

Patients' characteristics and perioperative outcomes

Characteristics	Total (n=60)	RYGB (n=28) (46.7%)	SG (n=32) (53.3%)
Age at surgery, yrs	17.3 ± 1.7 (12-19)	18.0 ± 1.3 (14-18)	16.5 ± 1.7 (12-19)*
Gender, n (%)			
Male	17 (28.3%)**	7 (25.0%)	10 (31.3%)
Female	43 (71.7%)	21 (75.0%)	22 (68.8%)
Weight (kg)	118 ± 19.4 (70-162)	121.7 ± 21.3 (88-162)	115 ± 17.4 (70-154)
BMI (kg/m^2)	42.5 ± 6.6 (25.7-59.1)	44.0 ± 6.6 (32.5-59.1)	41.2 ± 6.4 (25.7-55.8)
Excessive WT (kg)	54.2 ± 17.9 (7.4-91.8)	58.2 ± 18.9 (27.7-91.8)	50.7 ± 16.6 (7.4-88.1)
Comorbidities			
DM, preDM, n (%)	19 (31.7%)	9 (32.2%)	10 (31.3%)
HiBP, n (%)	32 (53.3%)	8 (28.6%)	24 (75.0%)*
Dyslipidemia, n (%)	46 (76.7%)	18 (64.3%)	28 (87.5%)
Fatty liver, n (%)	26 (43.3%)	7 (25.0%)	19 (59.4%)
OSA, n (%)	17 (28.3%)	5 (17.9%)	12 (37.5%)
GERD, n (%)	5 (8.3%)	1 (3.6%)	4 (12.5%)*
Arthritis, n (%)	8 (13.3%)	2 (7.1%)	6 (18.8%)
Psychiatric disorder, n (%)	8 (13.3%)	2 (7.1%)	6 (18.8%)
Operation time (min)	144 ± 79 (66-430)	171.4 ± 103.9 (85-430)	120 ± 35.6 (66-240)*
Blood loss (ml)	58.6 ± 74.5 (0-250)	38.3 ± 30.4 (30-500)	72 ± 92 (0-250)
Hospital stay (day)	3.6 ± 3.2 (1-15)	2.9 ± 2.0 (1-7)	4.0 ± 3.6 (1-15)

*p <0.05, between surgical procedure, ** between sex

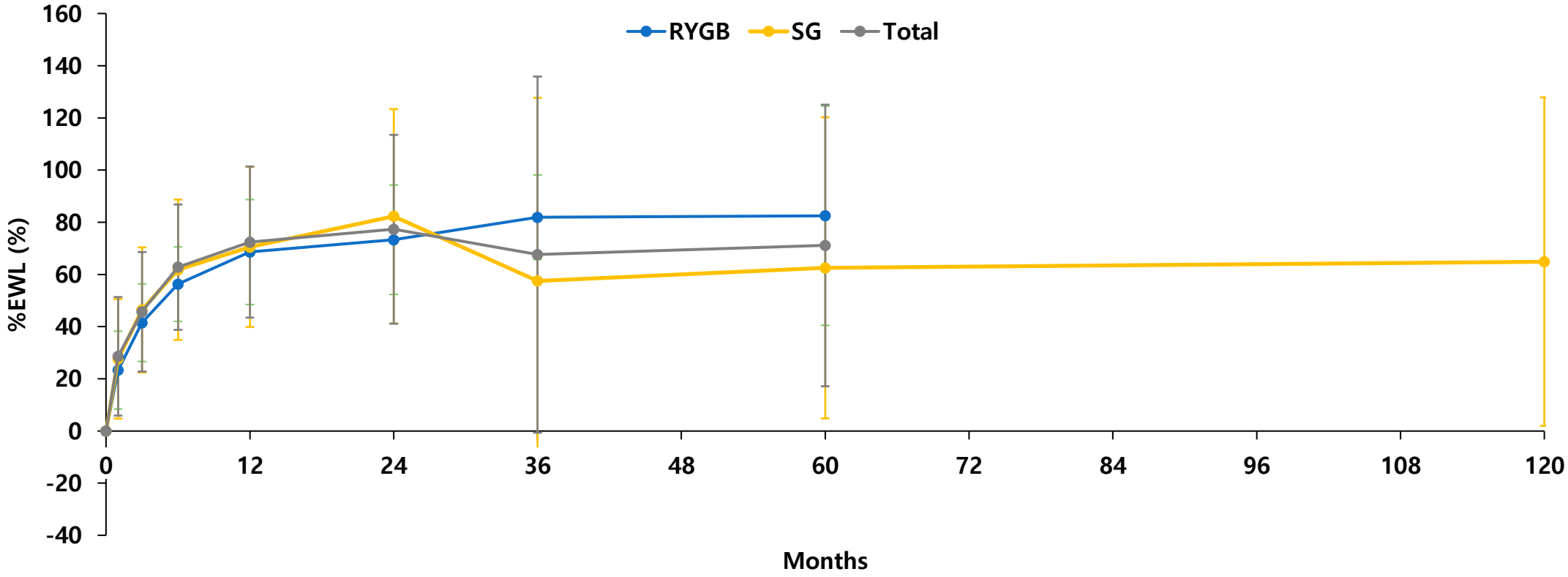
WT



WT variables	Procedures	Preop	1 month	3 months	6 months	12 months	24 months	36 months	60 months	120 months
No. of f/u patient	RYGB	28	24/28 (85.7%)	25/28 (89.3%)	25/28 (89.3%)	21/28 (75%)	17/28 (60.7%)	5/28 (17.9%)	7/28 (25%)	-
	SG	32	31/32 (96.8%)	28/32 (87.5%)	26/32 (81.3%)	29/32 (90.6%)	15/32 (46.9%)	10/32 (31.3%)	8/32 (25%)	2/32 (6.6%)
WT (kg)	RYGB	121.7 ± 21.3	108.1 ± 21.9	99.6 ± 19.9	90.9 ± 16.8	85.8 ± 18.2	81.1 ± 13.4	76.4 ± 14.0	71.2 ± 13.2	-
	SG	115.0 ± 17.4	103.5 ± 17.4	94.5 ± 16.9	86.9 ± 17.1	82.5 ± 17.1	78.0 ± 18.3	80.5 ± 18.9	85.6 ± 24.6	89.0 ± 28.3
	Total	118 ± 19.4	105.5 ± 19.5*	96.9 ± 18.4*	88.9 ± 16.9*	83.8 ± 17.4*	79.6 ± 15.7*	79.1 ± 17.0*	78.8 ± 20.7*	89.0 ± 28.3*

*p<0.05, vs. baseline

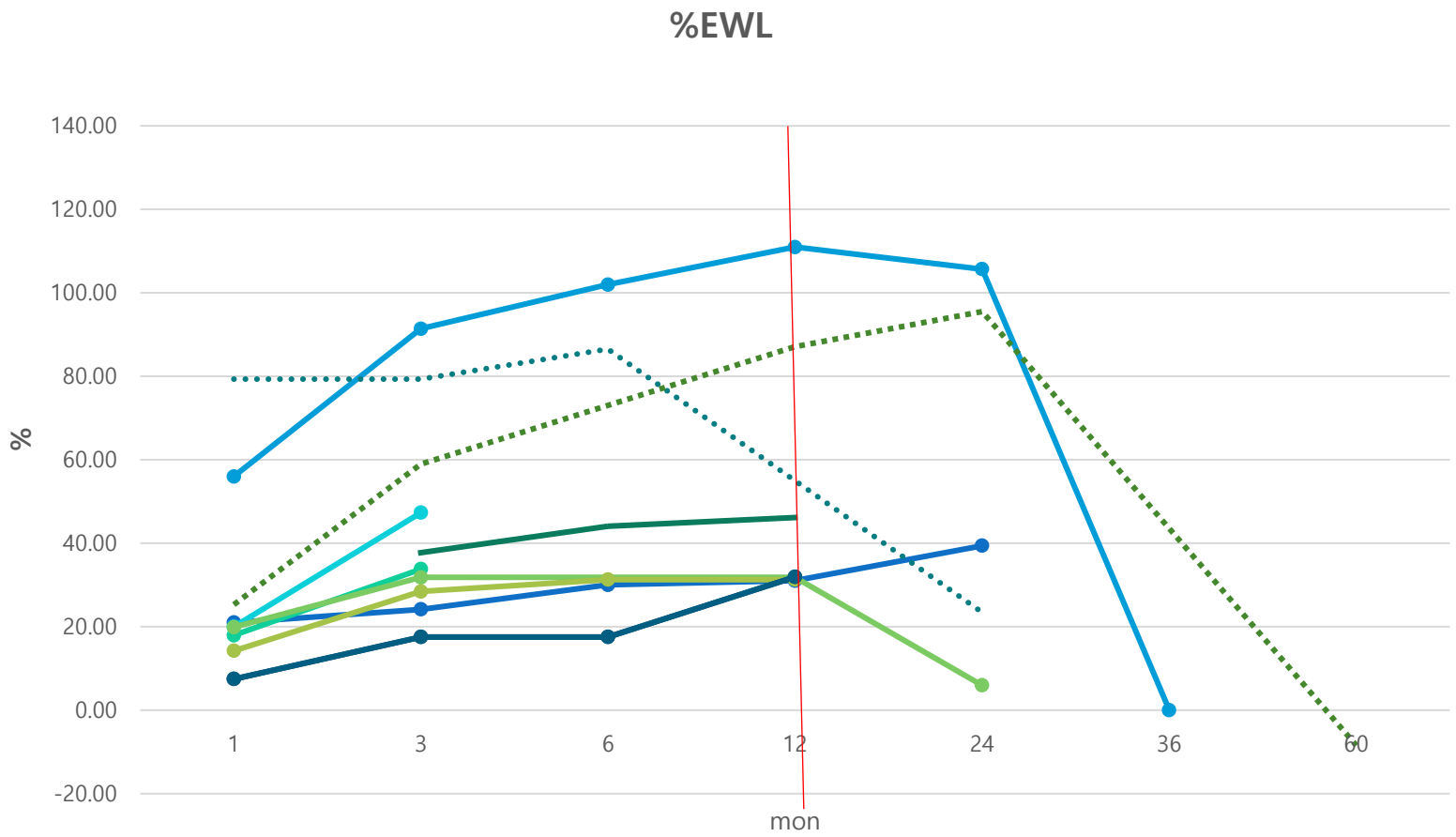
%EWL



WT variables	Procedures	Preop	1 month	3 months	6 months	12 months	24 months	36 months	60 months	120 months
No. of f/u patient	RYGB	28	24/28 (85.7%)	25/28 (89.3%)	25/28 (89.3%)	21/28 (75%)	17/28 (60.7%)	5/28 (17.9%)	7/28 (25%)	-
	SG	32	31/32 (96.8%)	28/32 (87.5%)	26/32 (81.3%)	29/32 (90.6%)	15/32 (46.9%)	10/32 (31.3%)	8/32 (25%)	2/32 (6.6%)
%EWL	RYGB		23.3 ± 14.9	41.5 ± 14.9	56.3 ± 14.3	68.6 ± 20.1	73.3 ± 21.0	81.9 ± 16.2	82.5 ± 42.0	-
	SG		27.6 ± 22.9	46.4 ± 24.0	61.8 ± 26.9	70.5 ± 30.7	82.2 ± 41.1	57.5 ± 70.2	62.5 ± 57.7	64.9 ± 63.0
	Total		28.6 ± 22.7*	45.7 ± 22.9*	62.8 ± 24.0*	72.4 ± 29.0*	77.3 ± 36.2*	67.6 ± 68.3*	71.1 ± 54.0*	64.9 ± 63.0*

*p<0.05, vs. baseline

Patient with %EWL <50% at the time of final survey



5 primary WT loss failures : 1 RYGB (n=21) & 4 SG (n=29), 1year postoperatively.
*3 WT regains. : 1 RYGB (n=17), 2 yrs; 1 SG (n=10), 3yrs; 1 RYGB (n=8), 5 yrs postoperatively.

Comorbidity resolution

Comorbidities		Total (n=60)		RYGB (n=28)		SG (n=32)	
		Baseline (n=60)	12 mon (n=50)	Baseline (n=28)	12 mon (n=21)	Baseline (n=32)	12 mon (n=29)
Glycemia control	Pre-diabetes, n (%)	7/60 (11.7)	3/50 (6.0)	1/28 (3.5)	1/21 (4.7)	6/32 (18.7)	2/29 (6.9)
	T2DM, n (%)	12/60 (20.0)	1/50 (2.0)	8/28 (28.5)	0/21 (0.0)	4/32 (12.5)	1/29 (3.4)
	FBG (mg/dl)	107.2 ± 40.4	88.8 ± 9.2*	110.7 ± 42.1	91.0 ± 4.5*	104.5 ± 39.5	87.4 ± 11.1*
	HbA1C (%)	6.0 ± 1.2	5.0 ± 0.3*	6.2 ± 1.1	5.1 ± 0.3*	5.8 ± 1.3	5.0 ± 0.3*
	Insulin (mcU/ml)	51.2 ± 38.2	12.1 ± 5.9*	52.9 ± 41.9	12.1 ± 5.9*	49.9 ± 35.9	-
Blood pressure	Hypertension, n (%)	32/60 (53.3)	7/50 (14.0)	8/28 (28.5)	2/21 (9.5)	24/32 (75.0)	5/29 (17.2)
	SBP (mmHg)	129.9 ± 16.3	119.4 ± 12.3	125.8 ± 18.7	130.3 ± 9.8	133.5 ± 13.3	117.1 ± 11.7*
	DBP (mmHg)	80.6 ± 12.6	73.6 ± 10.2	78.2 ± 14.6	72.0 ± 10.85	82.7 ± 10.3	78.0 ± 10.5*
Lipid	Dyslipidemia, n (%)	46/60 (76.7)	9/50, (18.0)	18/28 (64.2)	2/21 (9.5)	28/32 (85.7)	7/29 (24.1)
	T-cholesterol (mg/dl)	189.9 ± 38.8	175.6 ± 35.9	193.3 ± 23.4	157.3 ± 28.6*	187.4 ± 47.5	187.5 ± 35.7
	HDL (mg/dl)	48.2 ± 13.8	55.4 ± 12.2	48.2 ± 9.3	56.0 ± 8.3	48.2 ± 16.5	55.0 ± 14.4
	LDL (mg/dl)*§§	121.3 ± 33.1	102.0 ± 28.6	125.4 ± 22.5	85.8 ± 21.2*	118.3 ± 39.1	112.5 ± 28.2
	TG (mg/dl)	164.0 ± 82.9	91.3 ± 59.6*	168.8 ± 101.1	75.5 ± 25.6*	160.5 ± 67.6	101.7 ± 72.6*
Liver	Fatty liver	26/60 (43.3)	3/50 (6.0)	7/28	0/21	19/32	3/29
	AST (IU/L)	45.4 ± 35.8	17.1 ± 5.0*	50.2 ± 40.8	18.5 ± 6.4*	41.5 ± 31.1	16.2 ± 3.8*
	ALT (IU/L)	76.2 ± 73.0	15.1 ± 7.7*	78.0 ± 60.5	17.6 ± 8.2*	74.7 ± 83.1	13.5 ± 7.0*

*p <0.05, vs. baseline

Adverse event

- No mortality.

- Sleeve gastrectomy
  1 intraluminal, 1 peritoneal bleeding.
  2 re-admissions due to poor oral intake.

- Gastric bypass
  1 readmission due to vomiting.

Nutritional deficiency

Comorbidities		Total (n=60)		RYGB (n=28)		SG (n=32)	
		Baseline	12 mon	Baseline	12 mon	Baseline	12 mon
IDA	Hb (g/dl)	13.8 ± 1.2	13.3 ± 1.5	13.6 ± 1.1	12.8 ± 1.8*	14.0 ± 1.3	13.7 ± 1.3
	Serum iron	82.9 ± 42.7	95.0 ± 49.5	75.2 ± 43.8	87.7 ± 46.8	89.4 ± 41.7	99.9 ± 51.8
	Ferritin	143.3 ± 127.5	123.3 ± 303.5	175.5 ± 158.1	56.8 ± 23.8*	102.2 ± 56.8	179.7 ± 410.0
	TIBC	354.6 ± 95.3	349.3 ± 54.2	384.3 ± 92.5	352.7 ± 63.9	365 ± 103.5	345 ± 41.0
Calcium deficiency	Calcium	9.2 ± 2.0	9.4 ± 0.4	9.9 ± 0.2	9.4 ± 0.3	9.1 ± 2.1	9.4 ± 0.4
	Vitamin D	14.8 ± 6.2	16.7 ± 8.1	14.2 ± 7.4	13.3 ± 8.4	15.2 ± 5.5	17.7 ± 8.0
	PTH	42.5 ± 17.4	58.8 ± 81.2	41.5 ± 18.1	76.1 ± 8.5	47.1 ± 15.6	38.7 ± 15.8
Other nutritional deficiency	Albumin	6.8 ± 6.5	4.4 ± 0.2	13.4 ± 10.6	4.5 ± 0.3	4.4 ± 0.3	4.4 ± 0.2
	Folate	7.3 ± 6.6	6.3 ± 4.0	9.4 ± 10.1	8.5 ± 6.1	6.2 ± 3.8	5.5 ± 2.7
	Vitamin B12	476.3 ± 218.6	358.0 ± 198.3	432.4 ± 273.8	322.9 ± 99.1*	520.2 ± 138.5	468.5 ± 173.2
	Vitamin B1	155.6 ± 73.6	112.4 ± 62.7	188.0 ± 11.4	201.9 ± 16.1	150.3 ± 78.5	97.5 ± 59.5*

*p<0.05, vs. baseline

Summary

- RYGB & SG led to sustainable longer-term weight reduction in Korean adolescents with BMI > 30kg/m^2 offering the safety.
- Both procedures were equally effective on resolving the obesity-related comorbidities: hyperglycemia, hypertension, fatty liver disease, and dyslipidemia.
- Iron deficiency anemia and vitamin B12 deficiency should be considered after RYGB in adolescents.

Strength & Limitations

- The mid-term follow up outcomes in Asian obese adolescents (BMI >30kg/m2) after RYGB and SG.
- A 6–institutional multicenter data, based on KSMBS registry.
- The study included larger number of adolescents patients ever in this region.
- A retrospective study with relatively lower follow-up completion rate: probability of beta-errors in specific laboratory results & comorbidity improvement states.


thank you
danke
謝謝
ngiyabonga
teşekkür ederim
рахмат
Баярлалаа
спасибо
mersi
barka
welalin
tack
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dank je
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