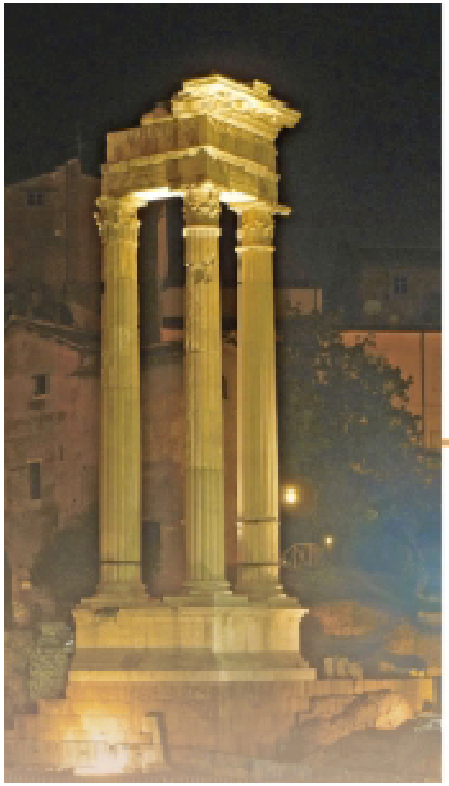


AMD ASSOCIAZIONE MEDICI DIABETOLOGI 1974

XIX CONGRESSO NAZIONALE AMD

Roma, 29 maggio - 1 giugno 2013

Rome Marriott Park Hotel

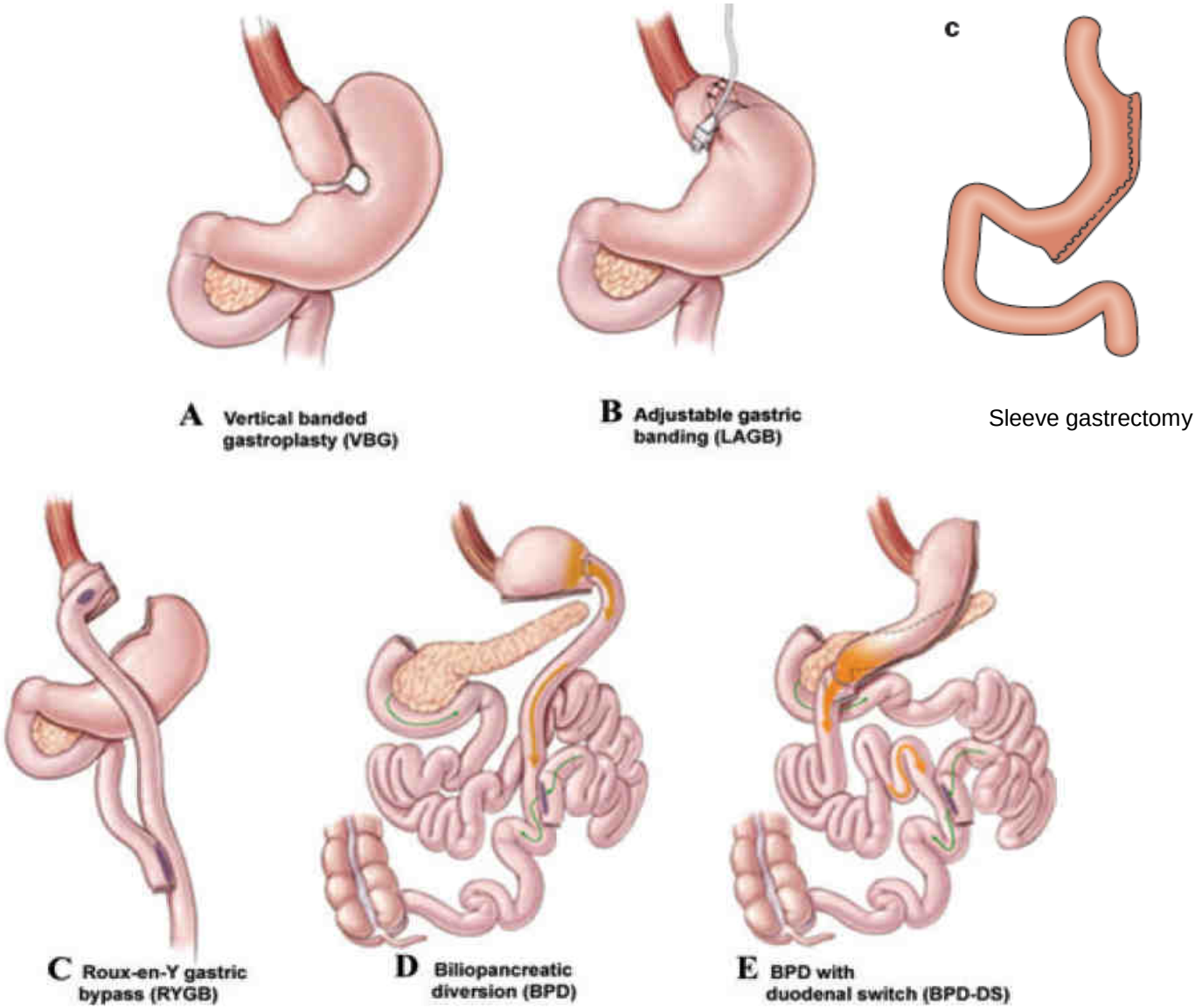
Effetti endocrino-metabolici della chirurgia bariatrica:non solo calo ponderale

Monica Nannipieri

Dipartimento di Medicina Clinica e Sperimentale
Università degli Studi di Pisa

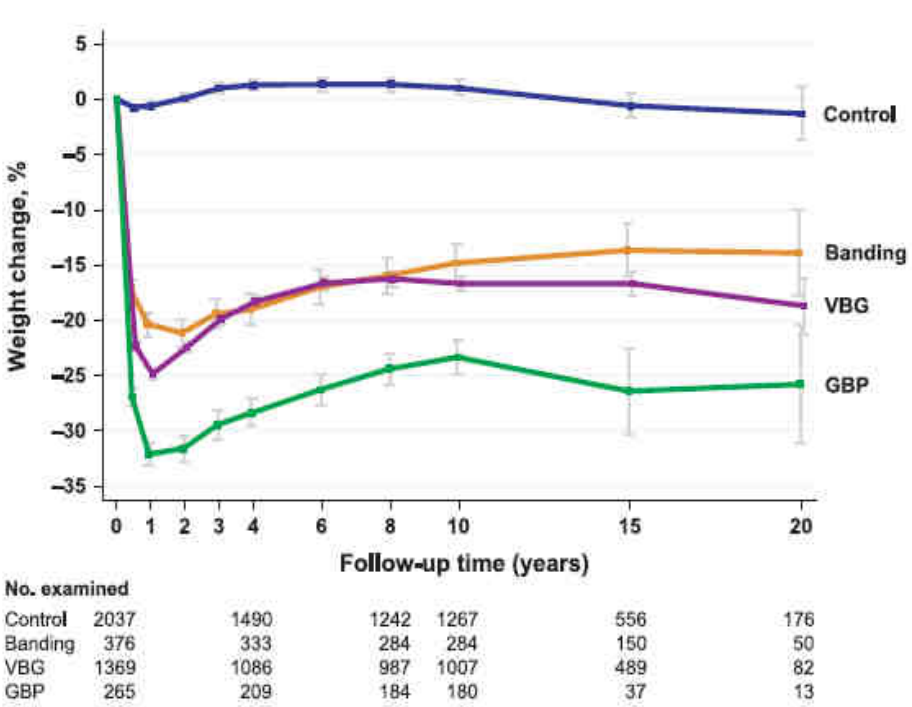
University of Pisa
IN SUPREMA DIGNITATIS
1343
School of Medicine

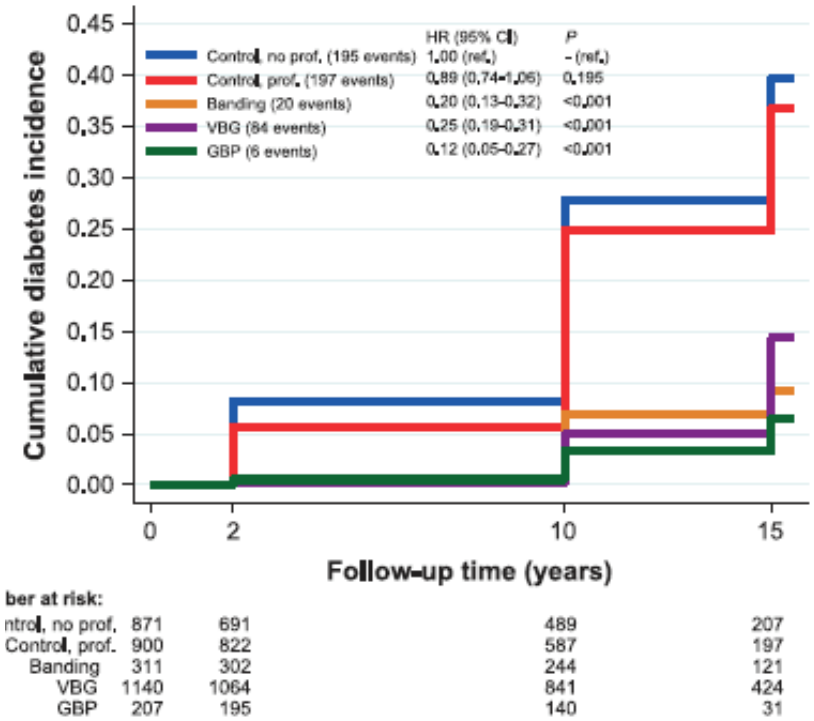
Bariatric/Metabolic Surgery



Rubino F, Nat. Rev. Endocrinol 2010

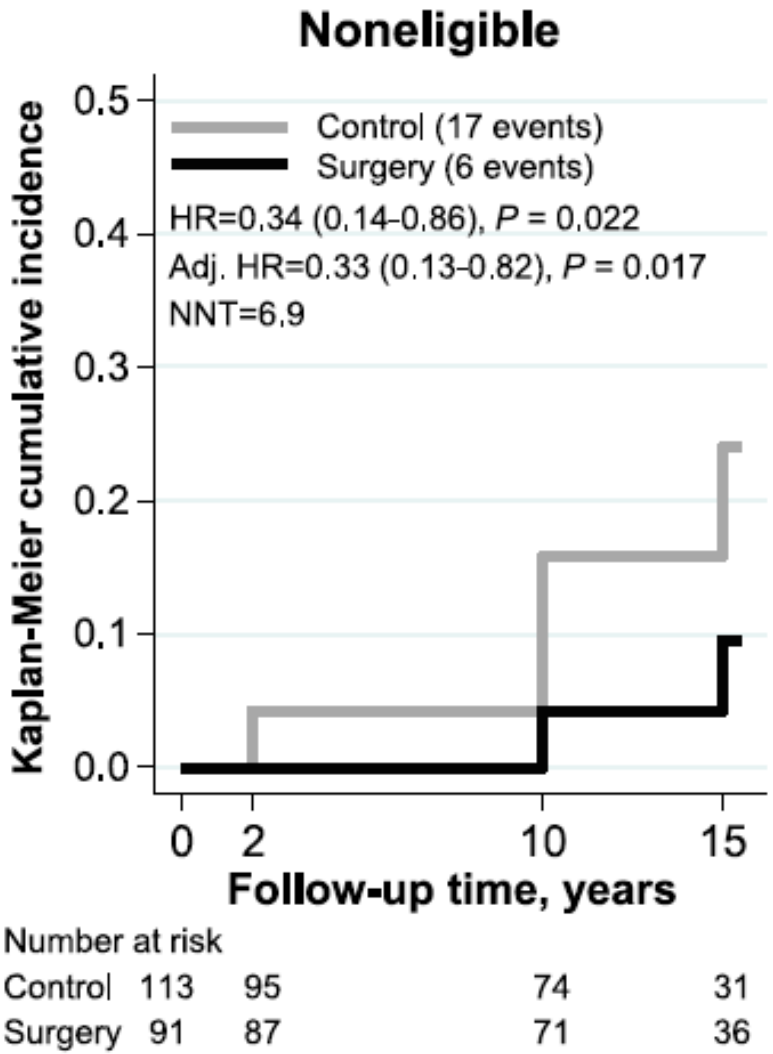
Cumulative Incidence of T2DM

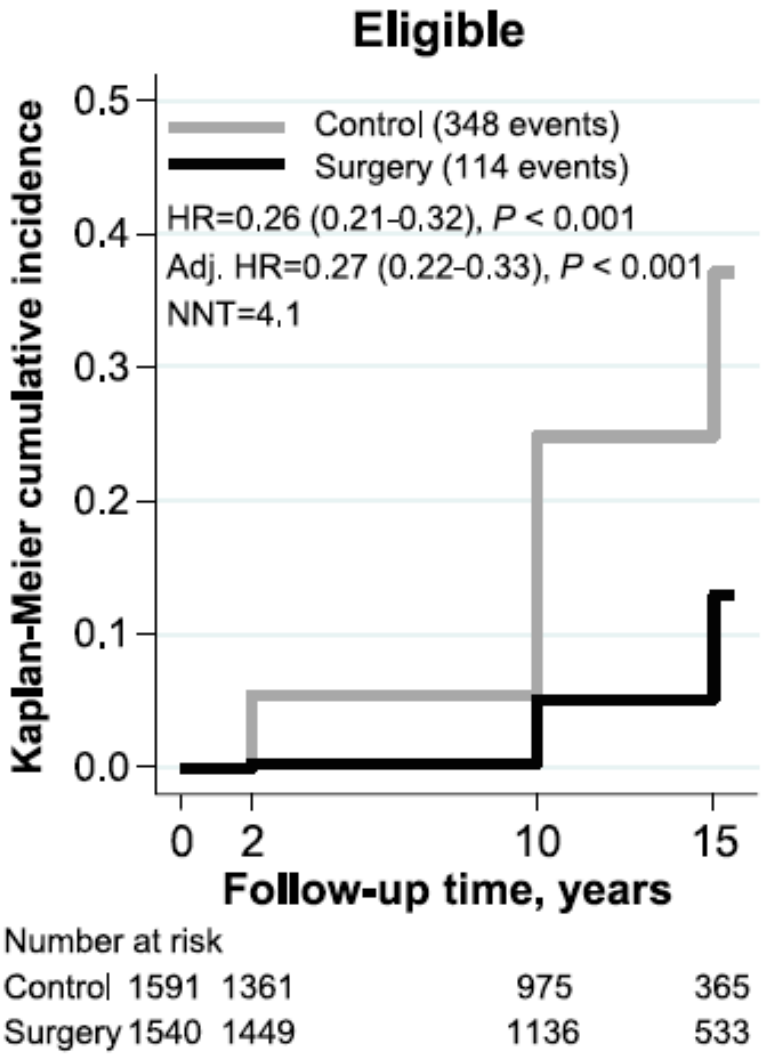




Sjostrom L, J Int Med 2012

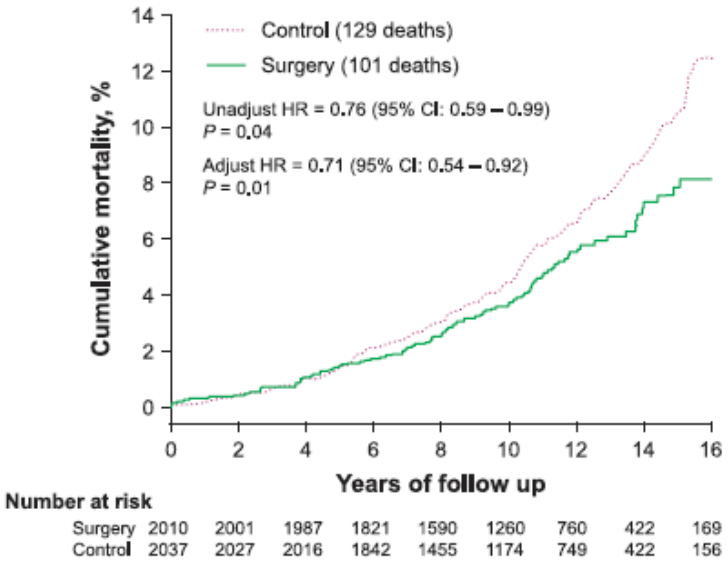
Cumulative Incidence of type 2 Diabetes over 15 years

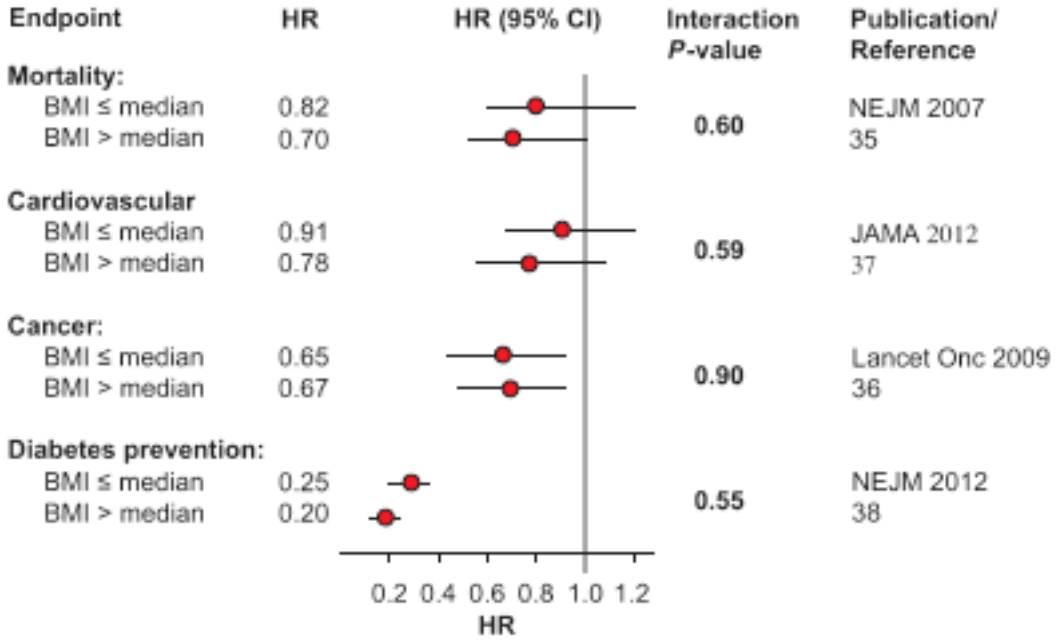




Sjoholm K, Diabetes Care 2013

Surgical treatment effect on indicated end-point





Sjostrom L, J Int Med 2012

Weight and type 2 diabetes after bariatric surgery: systematic review and meta-analysis

Results: weight loss, surgical procedure, and diabetes resolution

	Total	Gastric banding	Gastroplasty	Gastric bypass	BPD/DS
% excess bw loss	55.9	46.2	55.5	59.7	63.6
% resolved overall	78.1	56.7	79.7	80.3	95.1
2 <years	80.3	55.0	81.4	81.6	94.0
2 ≥years	74.6	58.3	77.5	70.9	95.9

BPD/DS = bilio-pancreatic diversion/duodenal switch

Buchwald H et al, Am J Med, 2009

Resolution

Diabetologia (2009) 52:2270–2276
DOI 10.1007/s00125-009-1511-8

FOR DEBATE

Resolution of type 2 diabetes following gastric bypass surgery: involvement of gut-derived glucagon and glucagonotropic signalling?

F. K. Knop

Remission

JAMA®

Adjustable Gastric Banding and Conventional Therapy for Type 2 Diabetes: A Randomized Controlled Trial
Dixon JD, 2008

Cure

Role of the incretin system in the remission of type 2 diabetes following bariatric surgery

G. Mingrone **NMCD 2008**

CLINICAL RESEARCH STUDY **2009**

THE AMERICAN JOURNAL of MEDICINE®

Weight and Type 2 Diabetes after Bariatric Surgery: Systematic Review and Meta-analysis

Henry Buchwald, MD, PhD,[a] Rhonda Estok, RN, BSN,[b] Kyle Fahrbach, PhD,[b] Deirdre Banel, BA,[b] Michael D. Jensen, MD,[c] Walter J. Pories, MD,[d] John P. Bantle, MD,[c] Isabella Sledge, MD, MPH[b]

How Do We Define Cure of Diabetes?

Table 1—*Summary of consensus definitions and recommendations*

Definitions
- Partial remission
  - Hyperglycemia below diagnostic thresholds for diabetes
  - At least 1 year's duration
  - No active pharmacologic therapy or ongoing procedures
- Complete remission
  - Normal glycemic measures
  - At least 1 year's duration
  - No active pharmacologic therapy or ongoing procedures
- Prolonged remission
  - Complete remission of at least 5 years' duration

HbA1c < 6.5 %
Glycemia 100-125 mg/dl

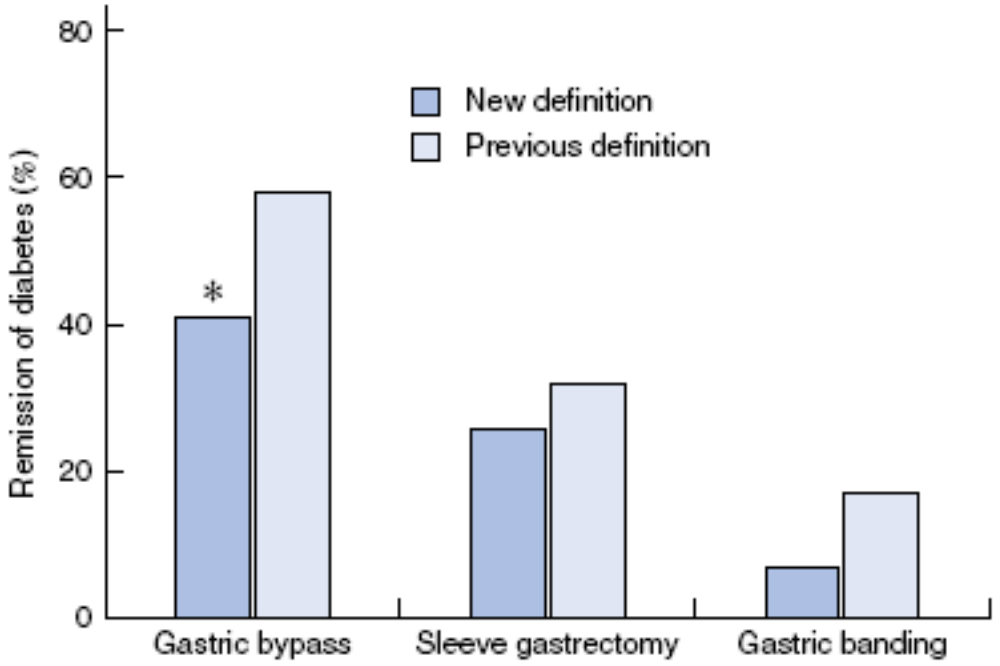
HbA1c < 6.0 %
Glycemia < 100 mg/dl

Recommendations
- Treatment goals for comorbid conditions
  - Same as those for patients with diabetes for patients with partial or complete remission of less than 5 years' duration
  - With prolonged remission, could consider goals appropriate for patients without diabetes, as long as there is no recurrence of diabetes and no cardiovascular disease
- Screening for microvascular complications
  - Same protocols as those for patients with diabetes for patients with partial or complete remission of less than 5 years' duration
  - With prolonged remission, could consider screening at reduced frequency depending on the status of each complication
  - With prolonged remission, only consider stopping screening for a particular complication completely if there is no history of that complication

Buse JB et al. Diab Care 2009

Original article

Effect of the definition of type II diabetes remission in the evaluation of bariatric surgery for metabolic disorders



Pournaras DJ et al, BJS 2011

Bariatric Surgery versus Conventional Medical Therapy for Type 2 Diabetes

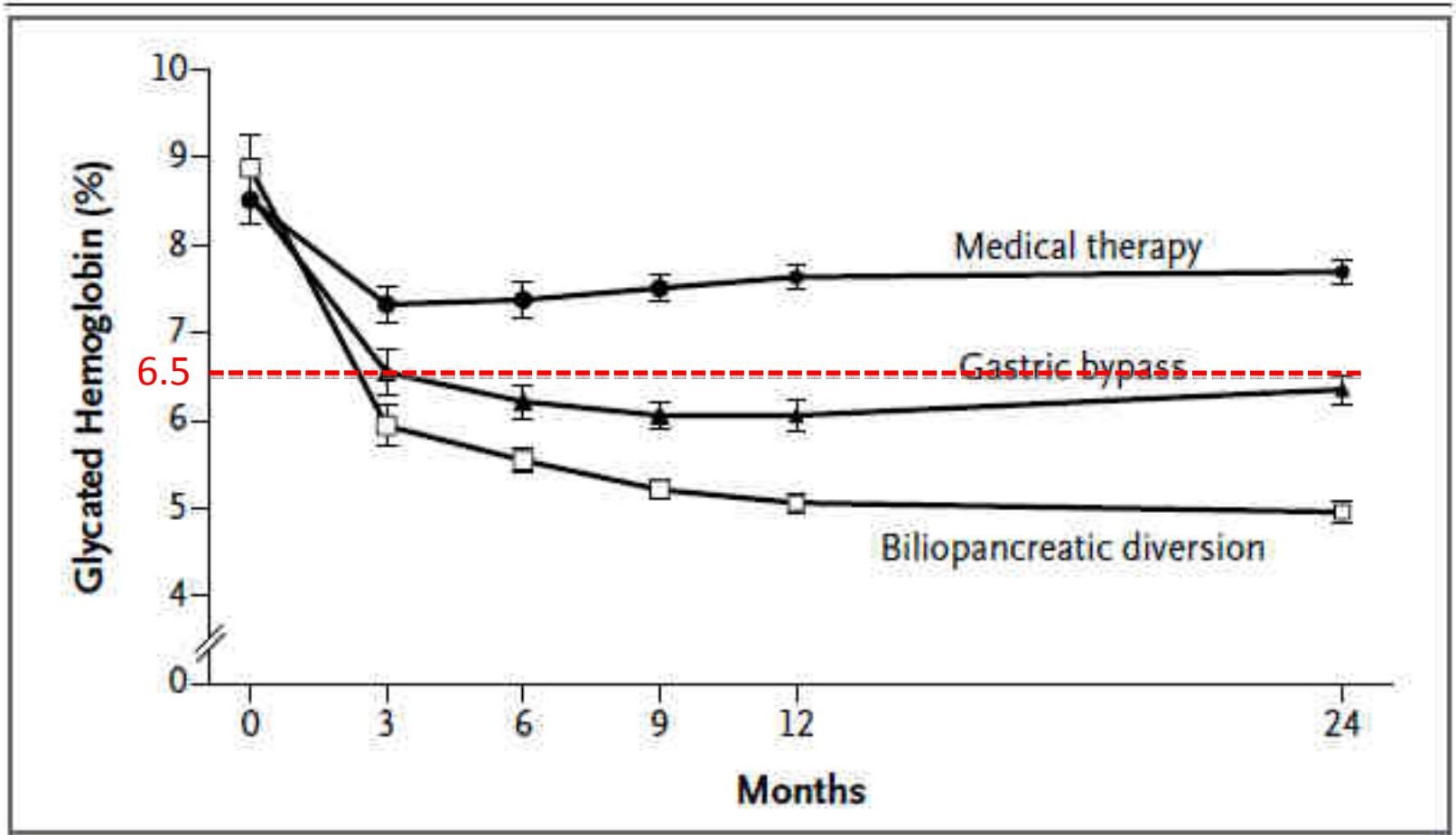


Figure 2. Glycated Hemoglobin Levels during 2 Years of Follow-up.

Mingrone G NEJM 2012

Metabolic Surgery for type 2 diabetes with BMI<35 kg/m2

Table 2: Outcomes of metabolic surgery: changes in BMI, fasting plasma glucose (FPG), and glycated hemoglobin (HbA1c), clinical outcomes of diabetes (% meds resolved and remission rate), and safety of metabolic surgery (complication and mortality).

	Author	BMI		Fasting plasma glucose		HbA1c (%)		% meds resolved	Remission	Complications	Mortality
		Mean preop (range)	Mean postop (range)	Mean preop (range)	Mean postop (range)	Mean preop (range)	Mean postop (range)				
1	Lee	30.1 kg/m^2	23 kg/m^2	195.8 mg/dL	106.3 mg/dL	9.7%	5.9%	90% (n = 18/20)	55% (n = 11/20)	11.3% (n = 7)	0 %
2	Boza	33.7 (30.4–35) kg/m^2	23.9 kg/m^2	145 mg/dL	109.9 mg/dL	8.1%	6.5%	—	83.3% (n = 25/30)	33.3% (n = 10)	0 %
3	de Sa	33.6 kg/m^2	25.7 kg/m^2	176.1 mg/dL	93.9 mg/dL	8.4%	6.0%	74.1% (n = 20/27)	48.1% (n = 13/27)	25.9% (n = 7)	0 %
4	Huang	30.8 (25.0–34.8) kg/m^2	23.7 kg/m^2	204.2 mg/dL	103.5 mg/dL	9.2%	5.9%	90.9% (n = 20/22)	63.6% (n = 14/22)	9.1% (n = 2)	0 %
5	Scopinaro	30.6 (25.3–34.9) kg/m^2	25.3 kg/m^2	220 mg/dL	149 mg/dL	9.3 (7.5–12.9) %	6.5%	83.3% (n = 25/30)	30% (n = 9/30)	16.7% (n = 5)	0 %
6	Shah	28.9 kg/m^2	23 kg/m^2	233 mg/dL	89.2 mg/dL	10.1%	6.1%	100% (n = 15/15)	100% (n = 15/15)	0% (n = 0)	0 %
7	Lee	31 kg/m^2	24.6 kg/m^2	240.1 mg/dL	132.9 mg/dL	10.1%	7.1%	—	50% (n = 10/20)	0% (n = 0)	0 %
8	DePauLa	28.2 (20–34.8) kg/m^2	—	215.3 mg/dL	105.4 mg/dL	8.9 (7.5–12.8) %	—	91.2% (n = 53/58)	63.7% (n = 37/58)	10.3% (n = 6)	0 %
9	DePaula	25.7 kg/m^2	21.8 (17.7–25.8) kg/m^2	218.1 (90–334) mg/dL	102.0 (73–161) mg/dL	8.7 (7.5–13.7) %	5.9 (4.8–8.5) %	95.7% (n = 66/69)	65.2% (n = 45/69)	7.3% (n = 5)	0 %
10	Ramos	27.1 (25–30) kg/m^2	24.4 (20.2–28.3) kg/m^2	171.3 (127.0–242.0) mg/dL	96.3 (78.0–118.0) mg/dL	8.8 (7.5–10.2) %	6.8 (5.8–7.9) %	90% (n = 18/20)	—	0% (n = 0)	0 %
11	Ferzli	27.5 (21.7–33.0) kg/m^2	27.3 (23–33) kg/m^2	208.9 (112.0–286.0) mg/dL	154.9 (63.0–315.0) mg/dL	9.4 (6.6–11.8) %	8.5 (6.3–12) %	14% (n = 1/7)	14 % (n = 1/7)	0% (n = 0)	0 %
12	Geloneze	26.1 (1.7) kg/m^2	25.6 (1.2) kg/m^2	183.8 mg/dL	156.8 mg/dL	8.9%	7.8%	0% (n = 0/12)	0% (n = 0/12)	16.7% (n = 2)	0 %
13	Chiellini	30.9 kg/m^2	25.1 kg/m^2	—	—	8.5%	5.7%	100% (n = 5/5)	—	—	0 %
14	Lee	31.7 kg/m^2	23.2 kg/m^2	168.7 mg/dL	88.6 mg/dL	7.3%	5.6%	—	89.5% (n = 40/44)	4.5% (n = 2)	0 %
15	Scopinaro	(32.0–34.6) kg/m^2	31.2) kg/m^2	(131–400) mg/dL	(68–146) mg/dL	—	—	100% (n = 7/7)	—	—	0 %
16	Cohen	29.6 (29.0–30.3) kg/m^2	28.3 (27–29.5) kg/m^2	—	83.0 (77–89) mg/dL	—	5.4 (5.0–5.7) %	100% (n = 2/2)	100% (n = 2/2)	0% (n = 0)	0 %
17	Cohen	32.5 (32.0–34.90 kg/m^2	—	146.0 (126–242) mg/dL	88.0 (60–94) mg/dL	—	<6.0%	100% (n = 37/37)	100% (n = 37/37)	0% (n = 0)	0 %
18	Noya	33.2 (24.0–38.9) kg/m^2	27.6 (20.46–32.4) kg/m^2	—	—	—	—	90% (n = 9/10)	90% (n = 9/10)	20% (n = 2)	0 %

Shimizu H, J Obes 2012

Recurrence of Diabetes After Metabolic Surgery Induced Remission

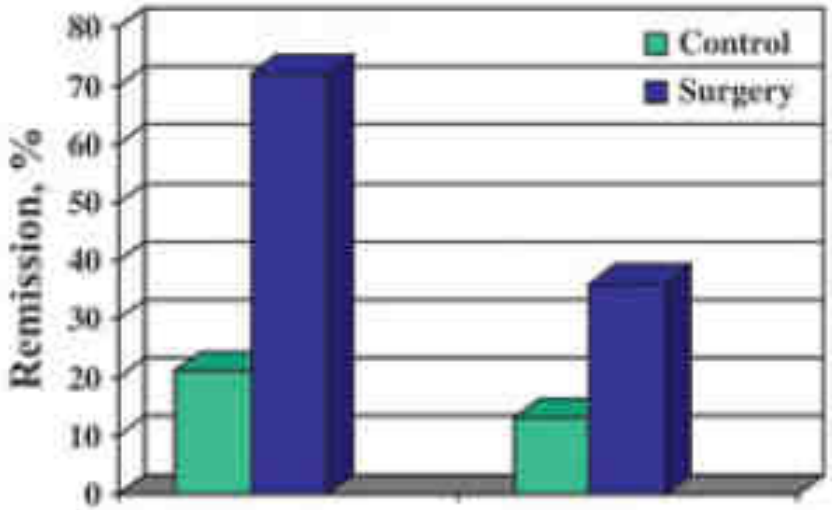
Table 3 Re-emergence of diabetes after resolution with bariatric surgery during long-term follow-up

Author	Surgical procedure	Number of patients with diabetes	Number (%) with remission of diabetes	Number (%) with relapse of diabetes	Time at relapse (years)
Sjostrom et al. [8]	Vertical banded gastroplasty (71 %) Gastric banding (24 %) Gastric bypass (5 %)	345	229 (72 %)	0 % 50 % 58.3 %	2 years 10 years 15 years
Kim and Richards [36]	Gastric bypass	219	156 (71 %)	11 (7.1 %)	2 to 5 years
DiGiorgi et al. [34]	Roux-en-Y-gastric bypass	42	27 (64 %)	10 (24 %)	≥3 years
Chikunguwo et al. [33]	Roux-en-Y gastric bypass	177	157 (89 %)	68 (43 %)	Within 5 years
Ramos et al. [35]	Not specified	72	66 (91.6 %)	14 (21.2 %)	5<2 years 3 at year 3 3 at year 4 3 at year 5

Lebovitz HE, Obes Surg 2013

Recurrence of Diabetes After Metabolic Surgery Induced Remission

(a) SOS. Remission from diabetes over 2 and 10 years



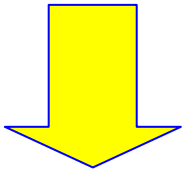
Number of subjects:	2 year	10 year
Control	248	84
Surgery	342	118
Adjusted Odds ratio	8.42	3.45
95% CI	5.68 - 12.5	1.64 - 7.28
P value	<0.001	<0.001

Sjostrom L, J Int Med 2012

Cure

remission of the disease

(correction of disease mechanisms)



↑ insulin sensitivity

and

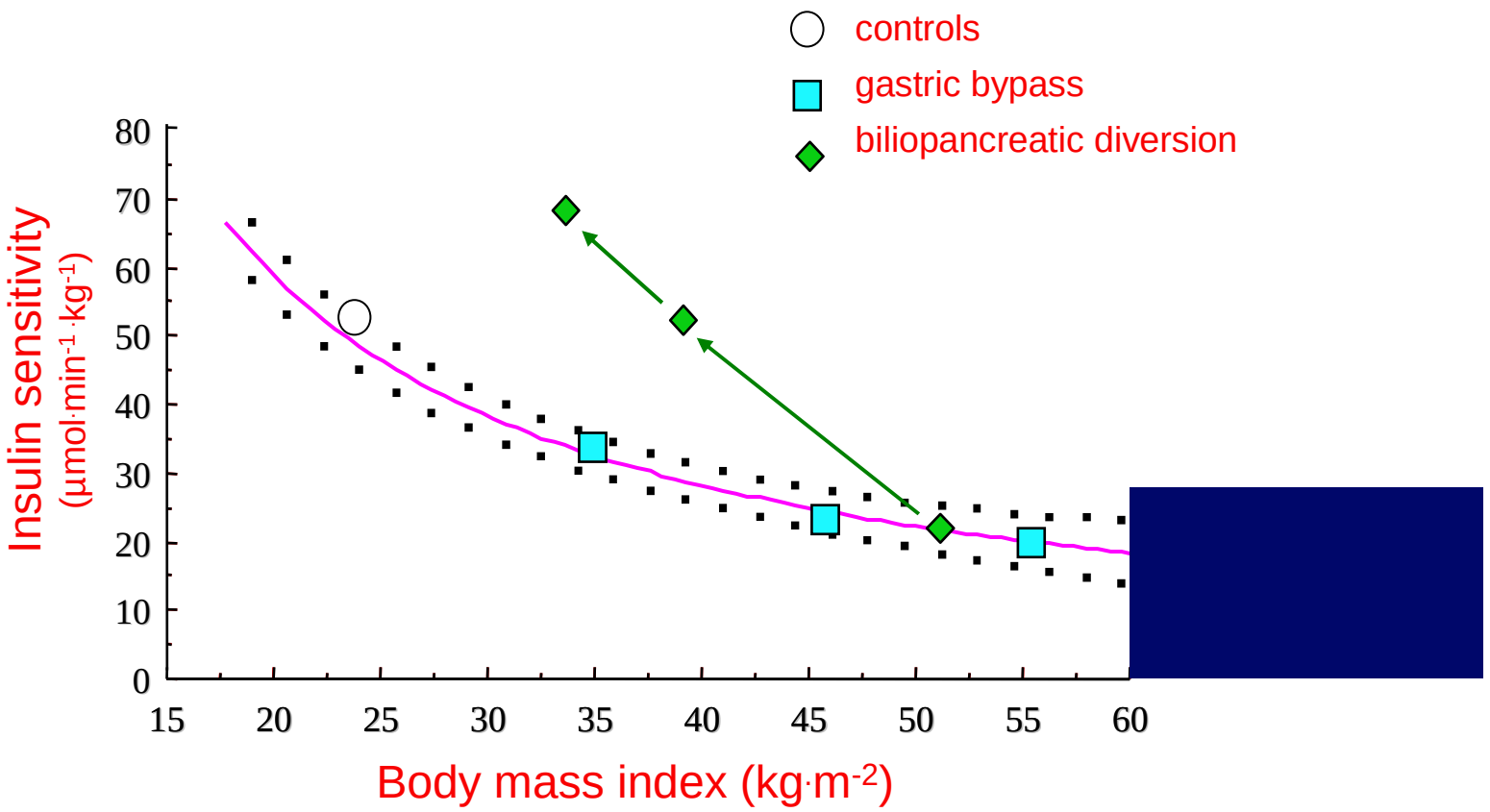
↑ β-Cell Function

Metabolic Effects

Insulin sensitivity and/or insulin secretion?

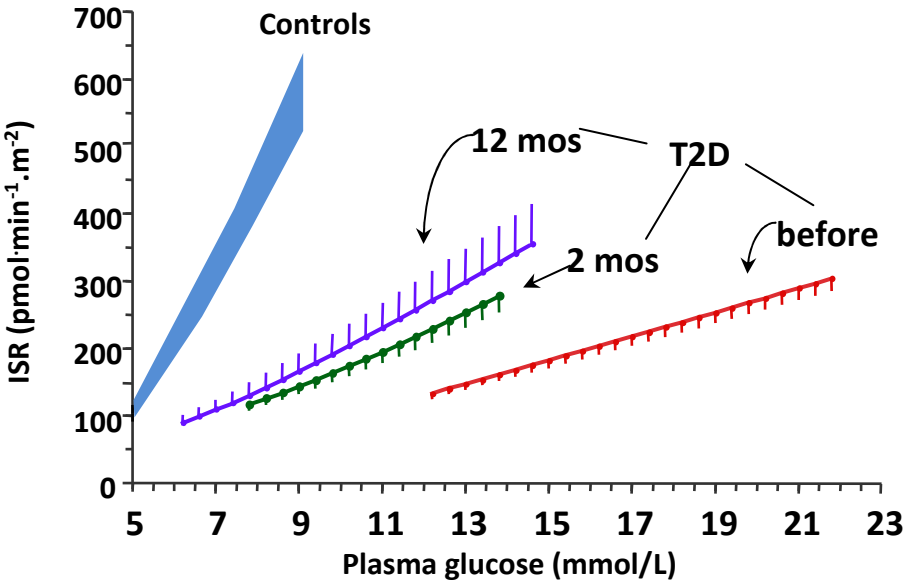
From Restrictive to Malabsorbitive Surgery

Insulin sensitivity after BPD vs RYGB

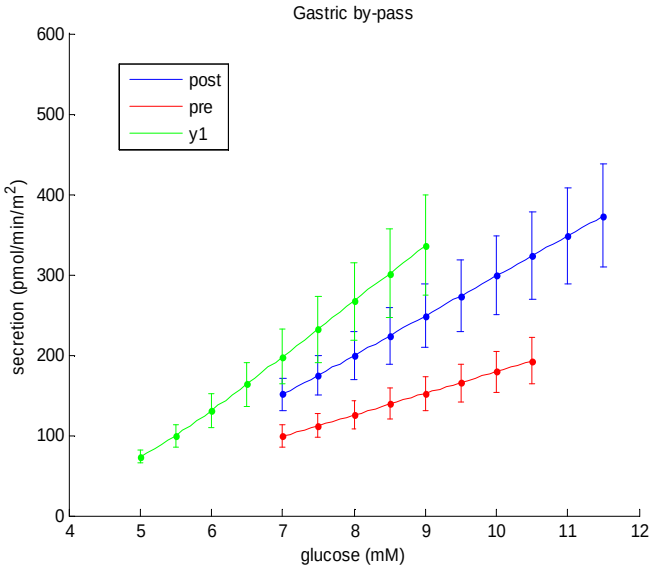


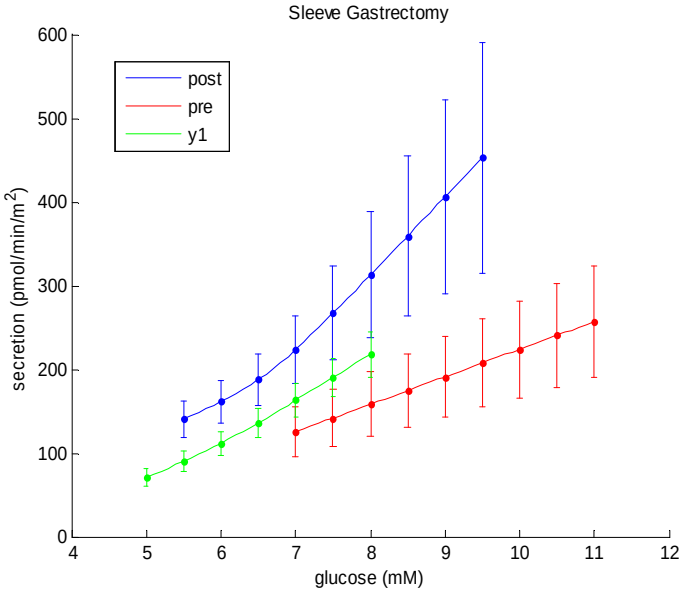
Muscelli et al. Am J Med 2005;118:51-7

β-cell Function in RYGB and DBP



Astiarraga B. JCEM 2013



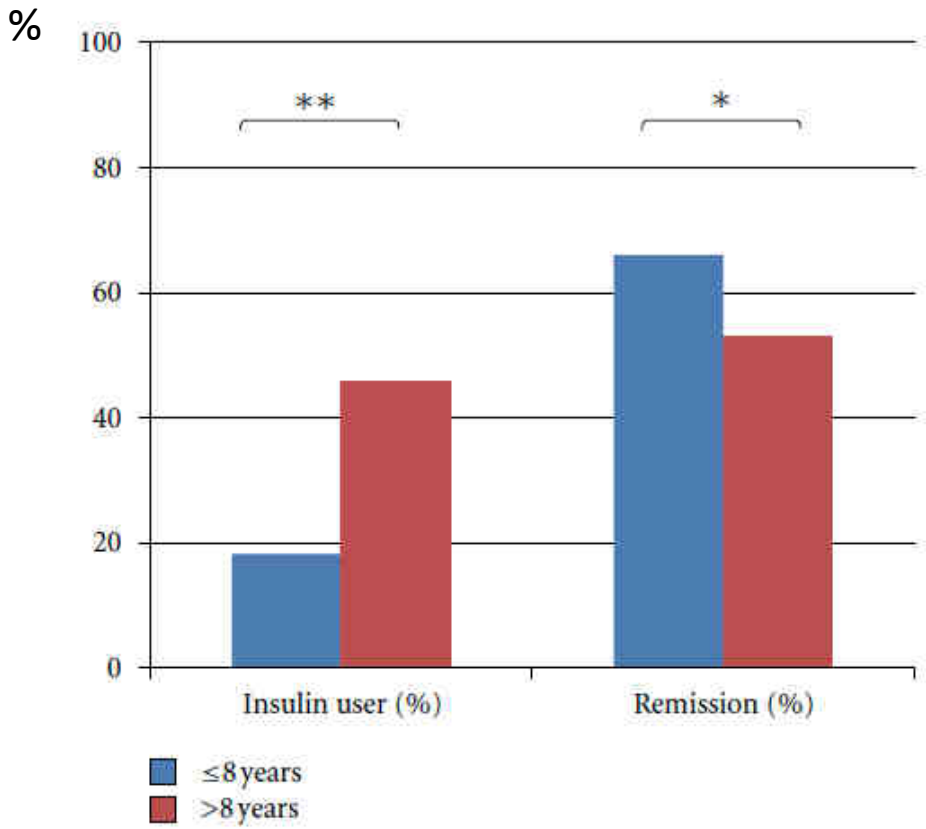


Nannipieri M. Diabetes Care Submitted

Predictive Factors of Type 2 Diabetes Remission 1 Year After Bariatric Surgery

DIABETES DURATION

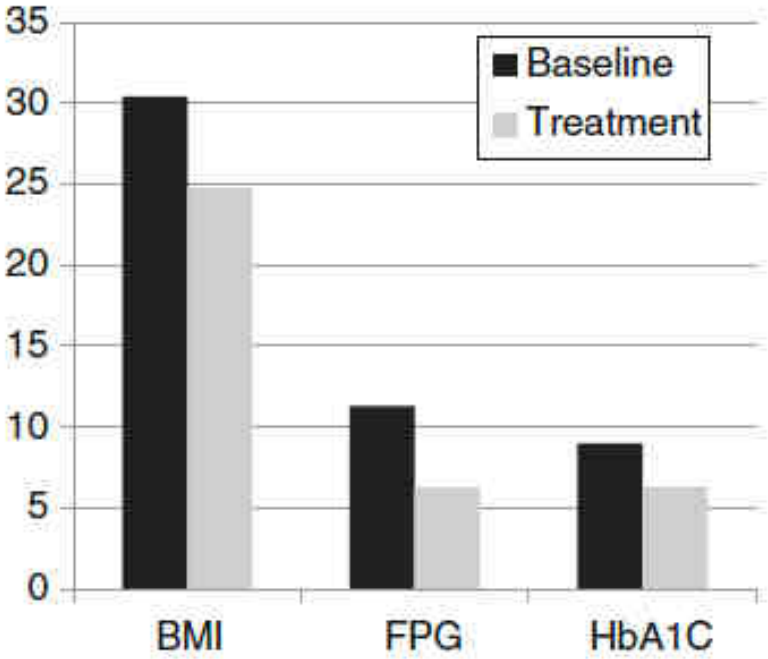
Clinical outcomes of diabetes according to duration of T2DM prior to surgery.

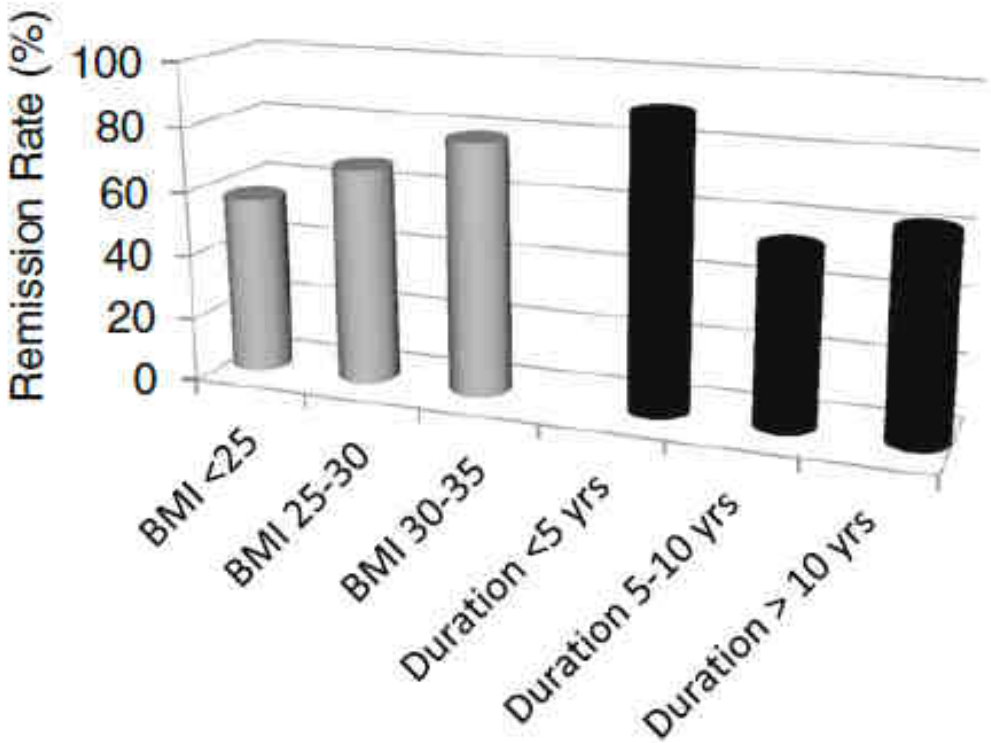


Shimizu H, J Obes 2012

BMI AND DIABETES DURATION

How Important Is Weight Loss in the Resolution of Diabetes by Bariatric Surgery?





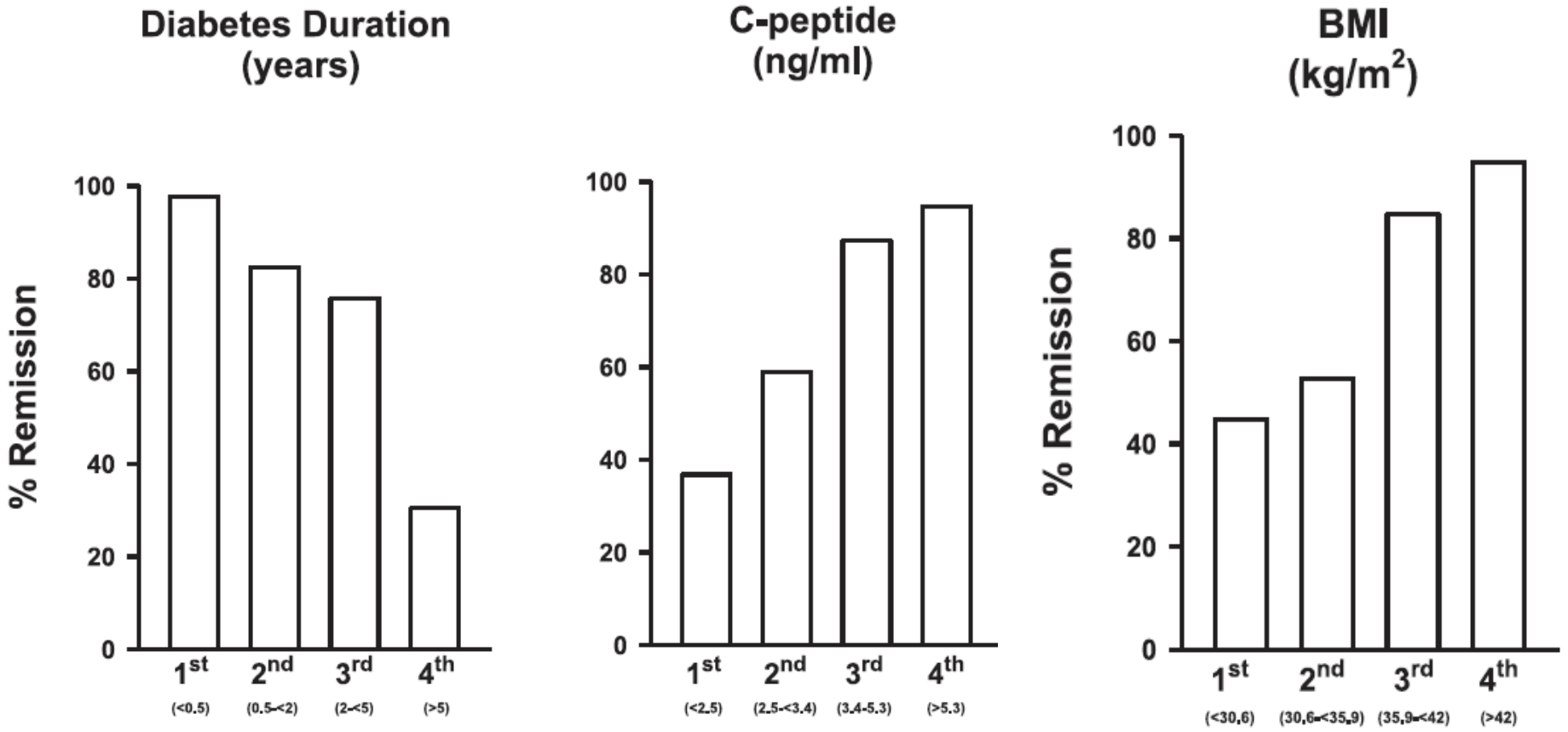
Lebovitz HE, Obes Surg 2013

Predictive Factors of Type 2 Diabetes Remission 1 Year

Variables	AUC ROC	*p* value	Cut-off value	Sensitivity (%)	Specificity (%)
Age	0.581	ns			
Sex	0.500	ns			
Surgical procedure					
AGB	0.530	ns			
GBP	0.581	ns			
LSG	0.540	ns			
Anthropometric parameters					
Baseline BMI	0.817	0.001	$\leq 50\ kg.m^{-2}$	70	80
1-year BMI	0.777	0.001	$<35\ kg.m^{-2}$	65	93
%EBL at 3 months	0.665	ns			
%EBL at 6 months	0.584	ns			
%EBL at 1 year	0.681	ns			
Baseline glucose homeostasis parameters					
HbA1c	0.824	0.0001	≤7.1 %	81	79
Fasting glucose	0.808	0.0001	<1.14 g/l	73	87
Duration of diabetes	0.828	0.0001	≤4 years	79	80
Anti-diabetic treatment	0.858	0.0001	Is not insulin	96	60
Baseline surrogates of insulin resistance					
Fasting insulinaemia	0.568	ns			
Triglyceridemia	0.519	ns			
HDL cholesterol	0.504	ns			
CRP	0.668	ns			
HOMA-IR	0.573	ns			
QUICKI	0.620	ns			
McAuley index	0.514	ns			

Robert M, Ob Surg 2013

Predicting the Glycemic Response to Gastric Bypass Surgery in Patients With Type 2 Diabetes



Dixon JB, Diabetes Care 2013

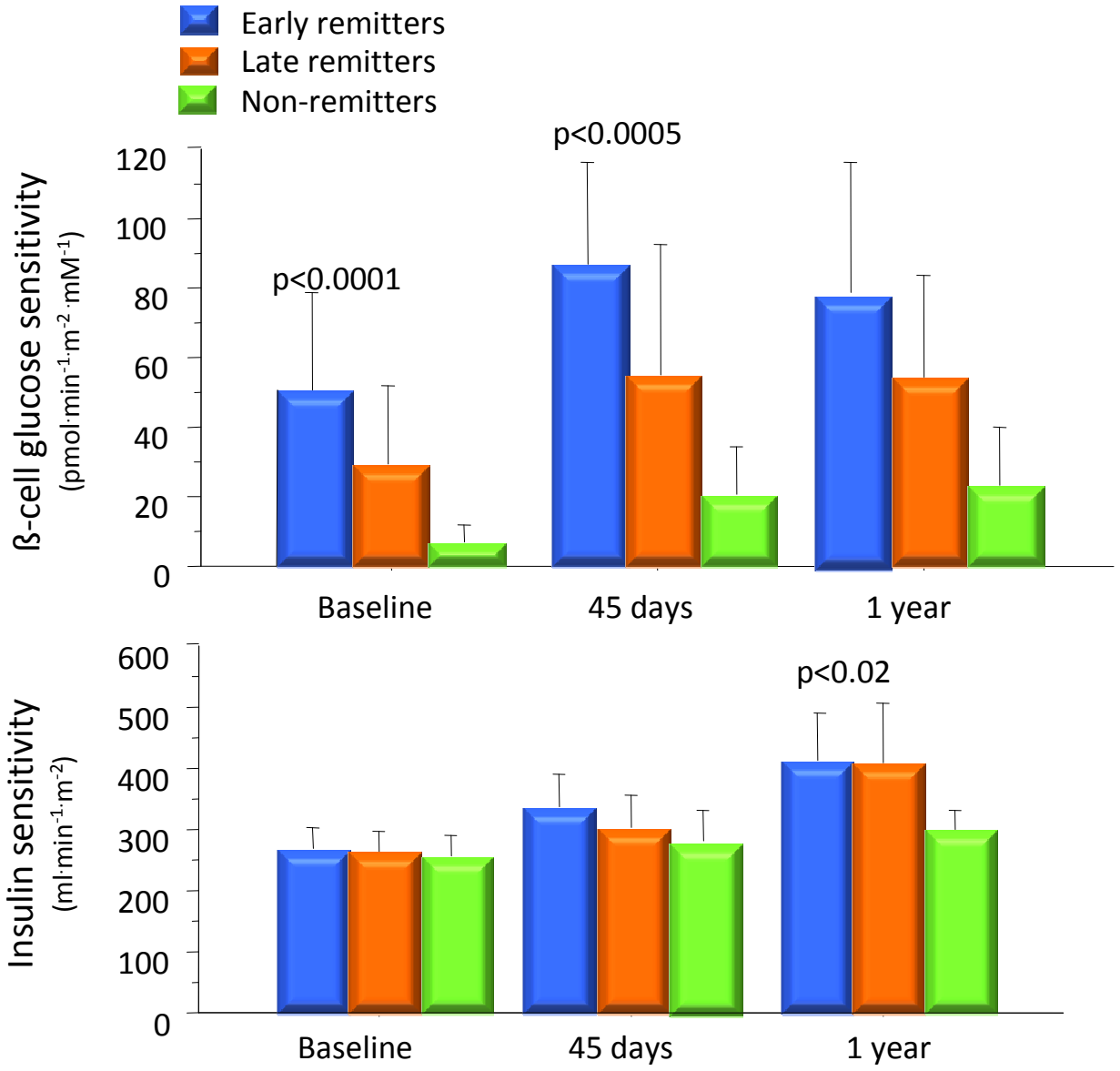
Remission of Type 2 Diabetes
When?

Predictors of successful sustained euglycemia

Predictors	References
At baseline	
Better glycemic control	[14,16]
Higher late-phase insulin secretion	[17]
Higher BMI	[14,16]
Higher insulin resistance	[15]
Shorter duration of T2DM	[16,18]
Fewer chronic vascular complications	[16]
Greater self-care adherence	[15]
During insulin therapy	
Faster achievement of glycemic targets	[14,17]
Smaller exogenous insulin requirement	[13,17]
Immediately after insulin therapy	
Better glycemic control	[11,13–15,18]
Greater improvement in β-cell function	[11,14,15,17]

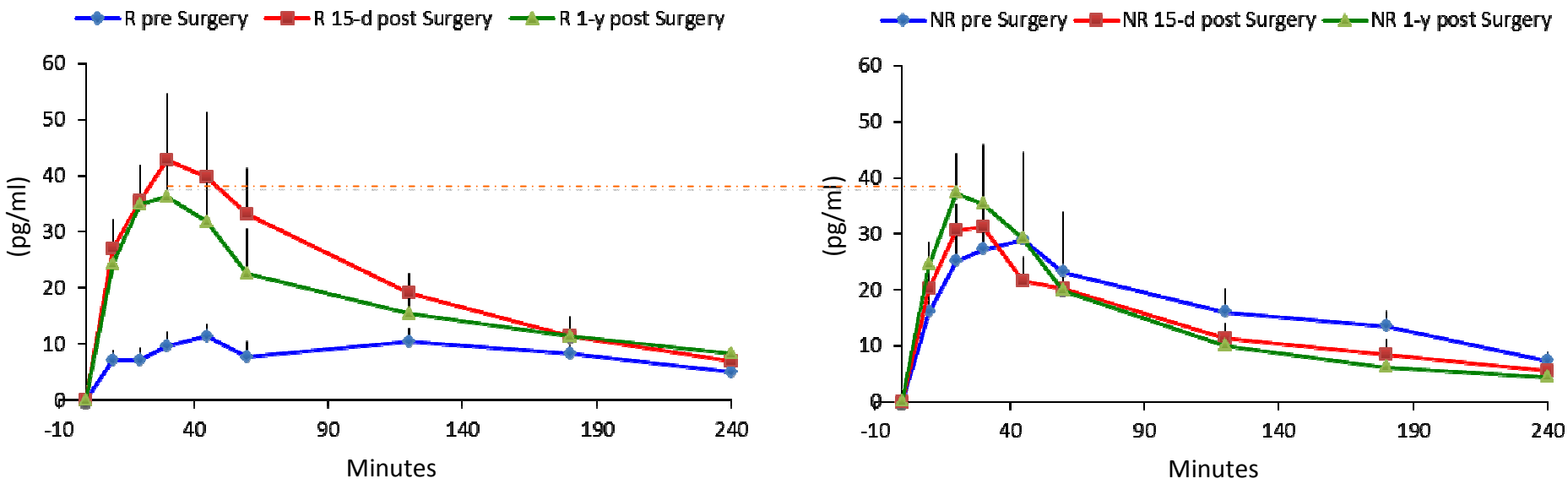
Retnakaran R, Zinman B, Diabetes, Obesity and Metabolism, 2012.

β-Cell Function and Insulin Sensitivity in the Remission of Type 2 Diabetes after RYGB



Nannipieri M. et al, JCEM 2011

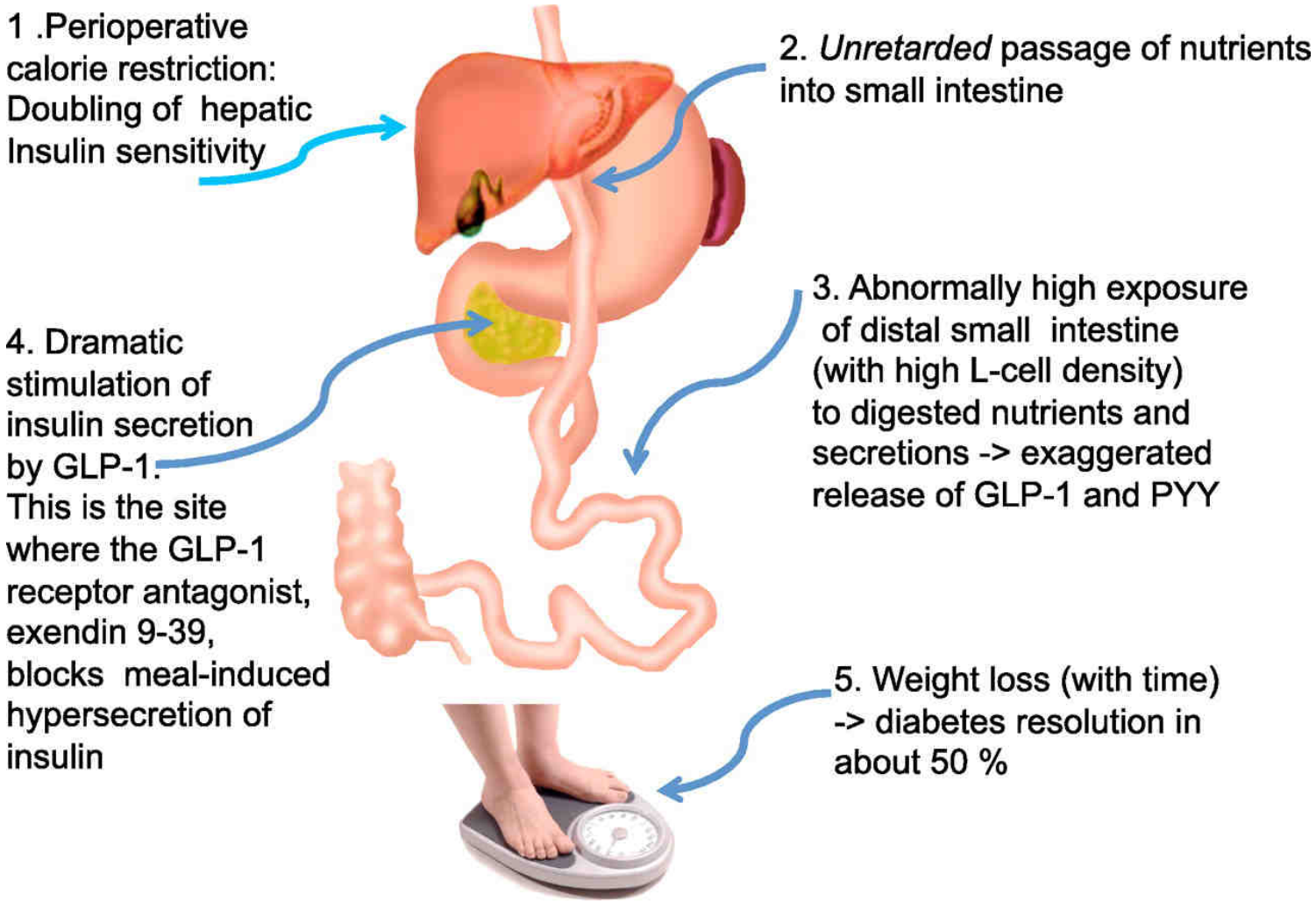
GLP-1 in remitters and no-remitters



When predictors of diabetes remission were tested in a logistic regression model, presurgery ß-cell glucose sensitivity (positive, $p<0.0001$), and the MMT-stimulated GLP-1 response (negative, $p=0.004$) were the only variables significantly associated with partial diabetes remission at 1 year.

Nannipieri M et al Diabetes Care, Submitted

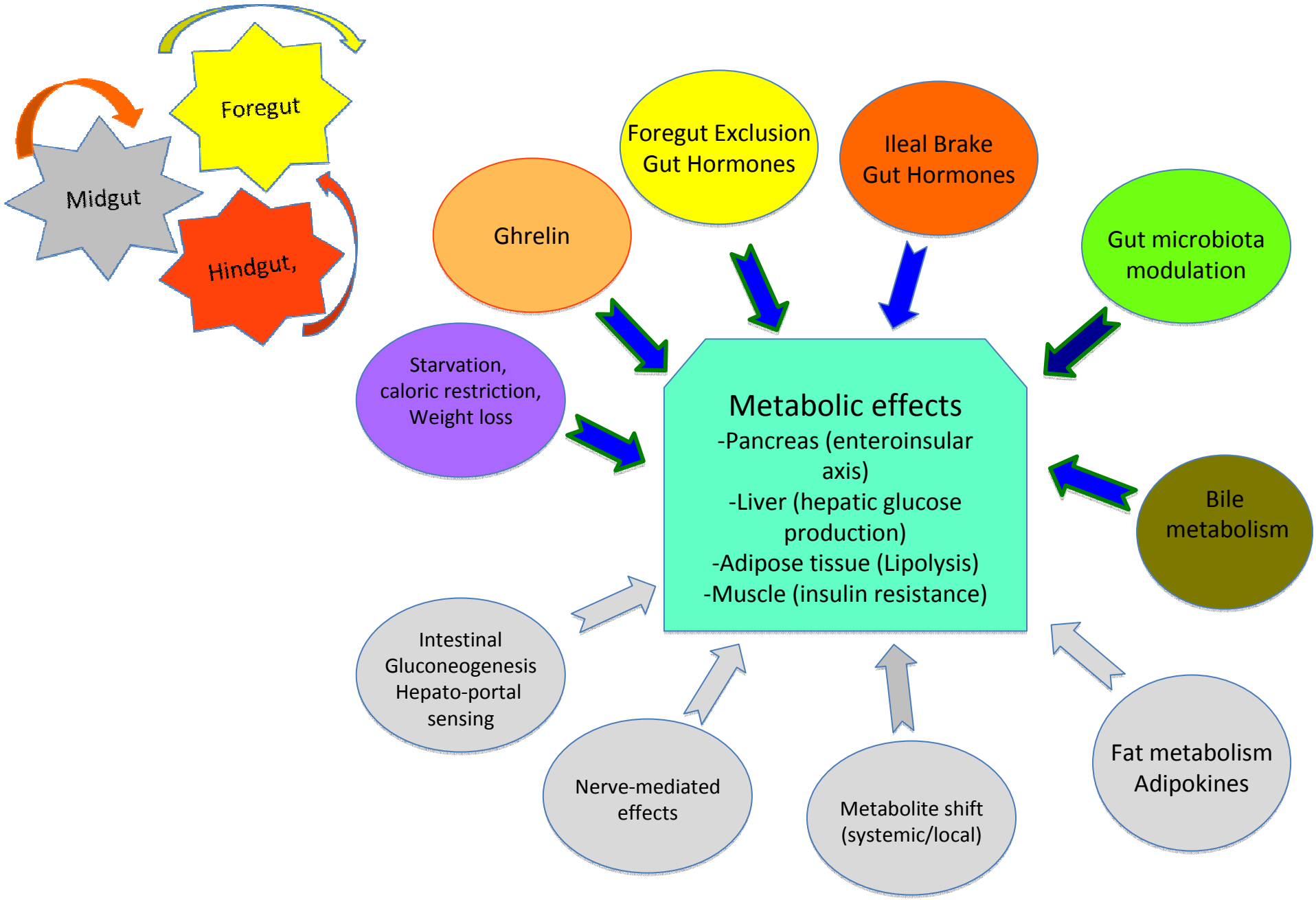
Proposed mechanism of diabetes resolution after RYGB surgery.



American Diabetes Association.

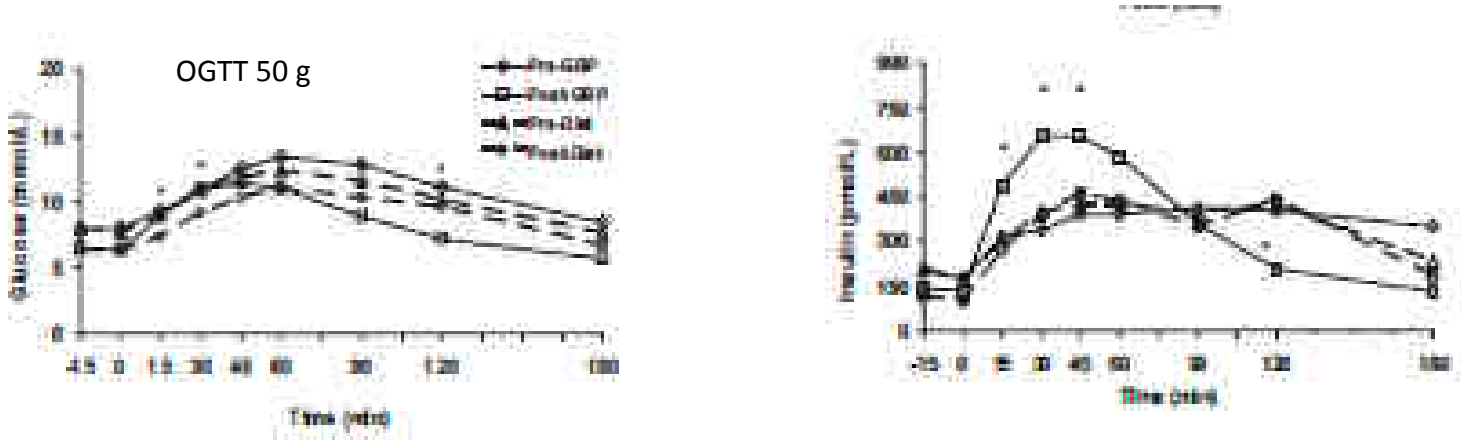
Holst J J Diabetes 2011;60:2203-2205

Mechanisms Facilitating T2DM Improvement/Resolution

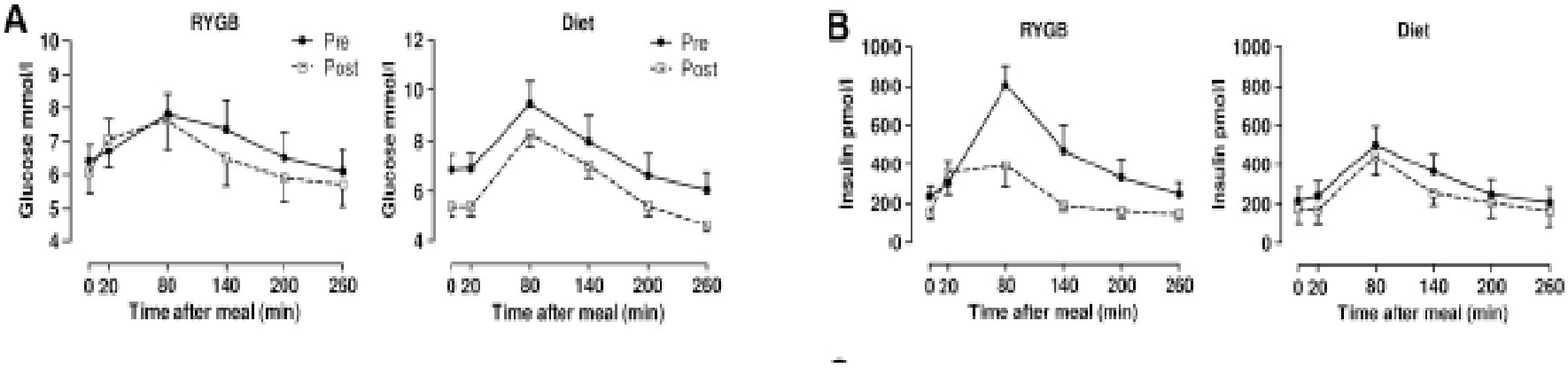



Starvation,
Caloric restriction,
Weight loss

Effect of Weight Loss by Gastric Bypass Surgery *Versus Hypocaloric Diet (10 days) on Glucose and Incretin* Levels in Patients with Type 2 Diabetes

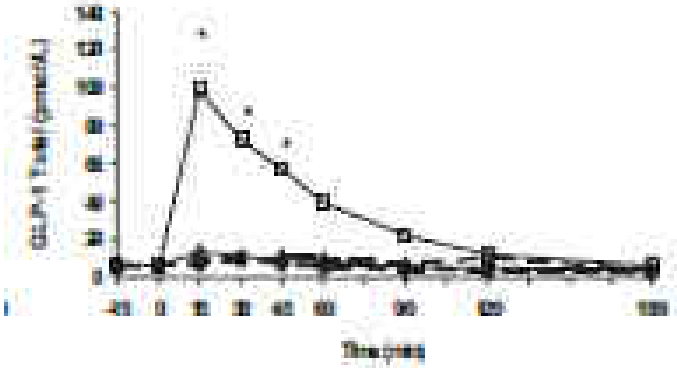


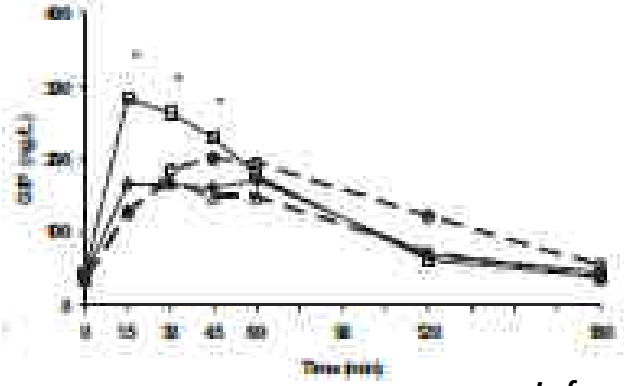
Laferrere B, JCEM 2008

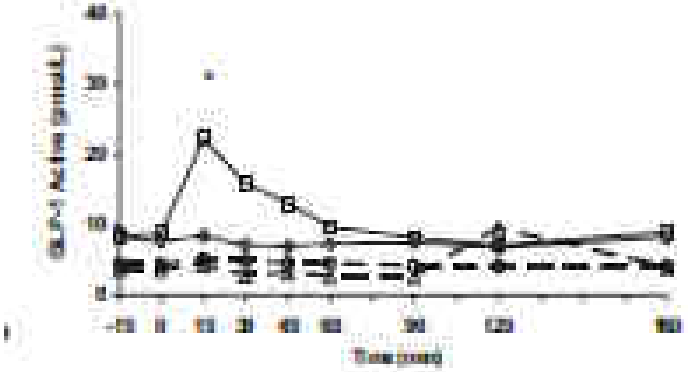


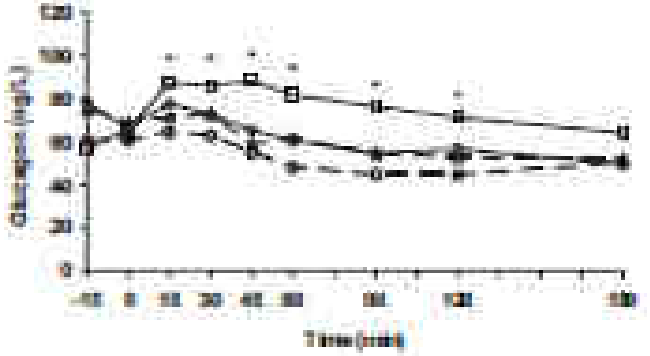
Isbell JM. et al Diabetes Care 2010

Effect of Weight Loss by Gastric Bypass Surgery *Versus Hypocaloric Diet on Glucose and Incretin* Levels in Patients with Type 2 Diabetes

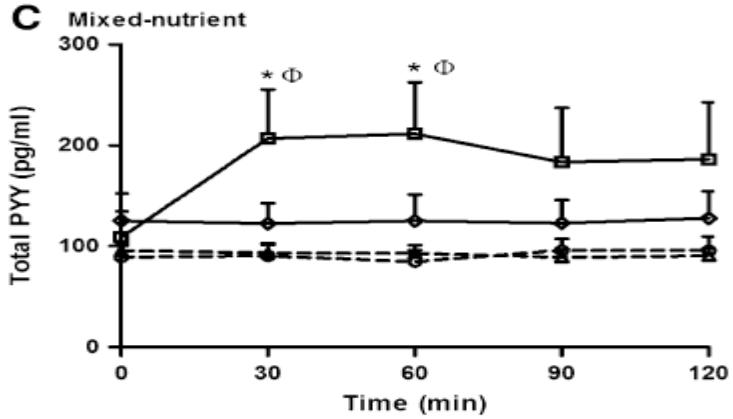


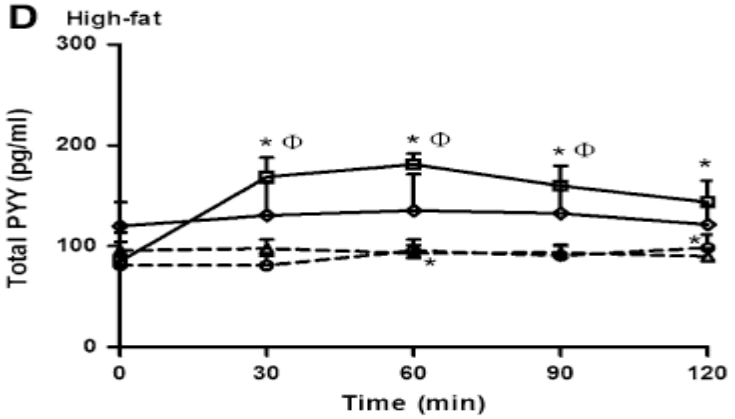






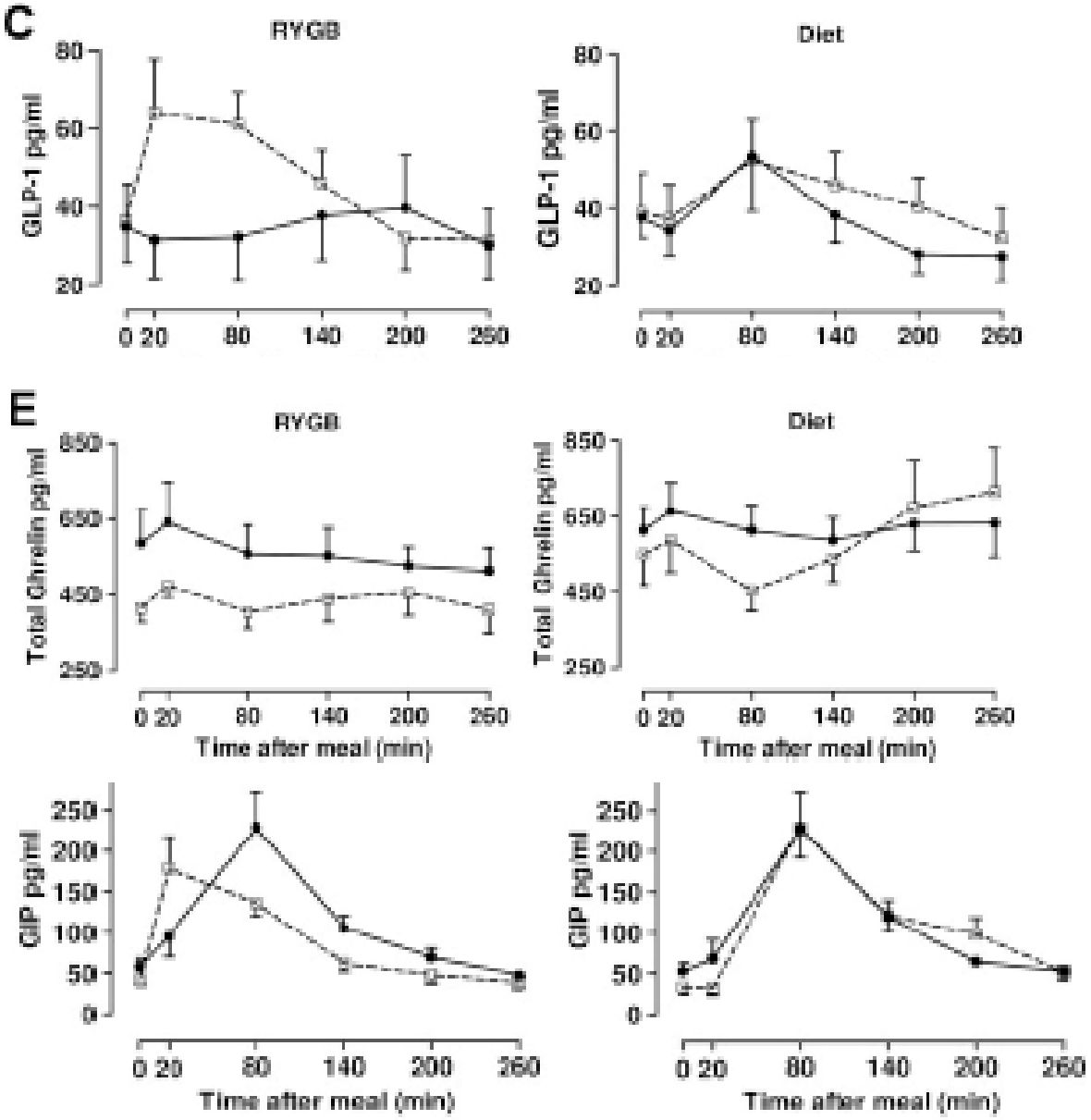
Laferrere B, JCEM 2008



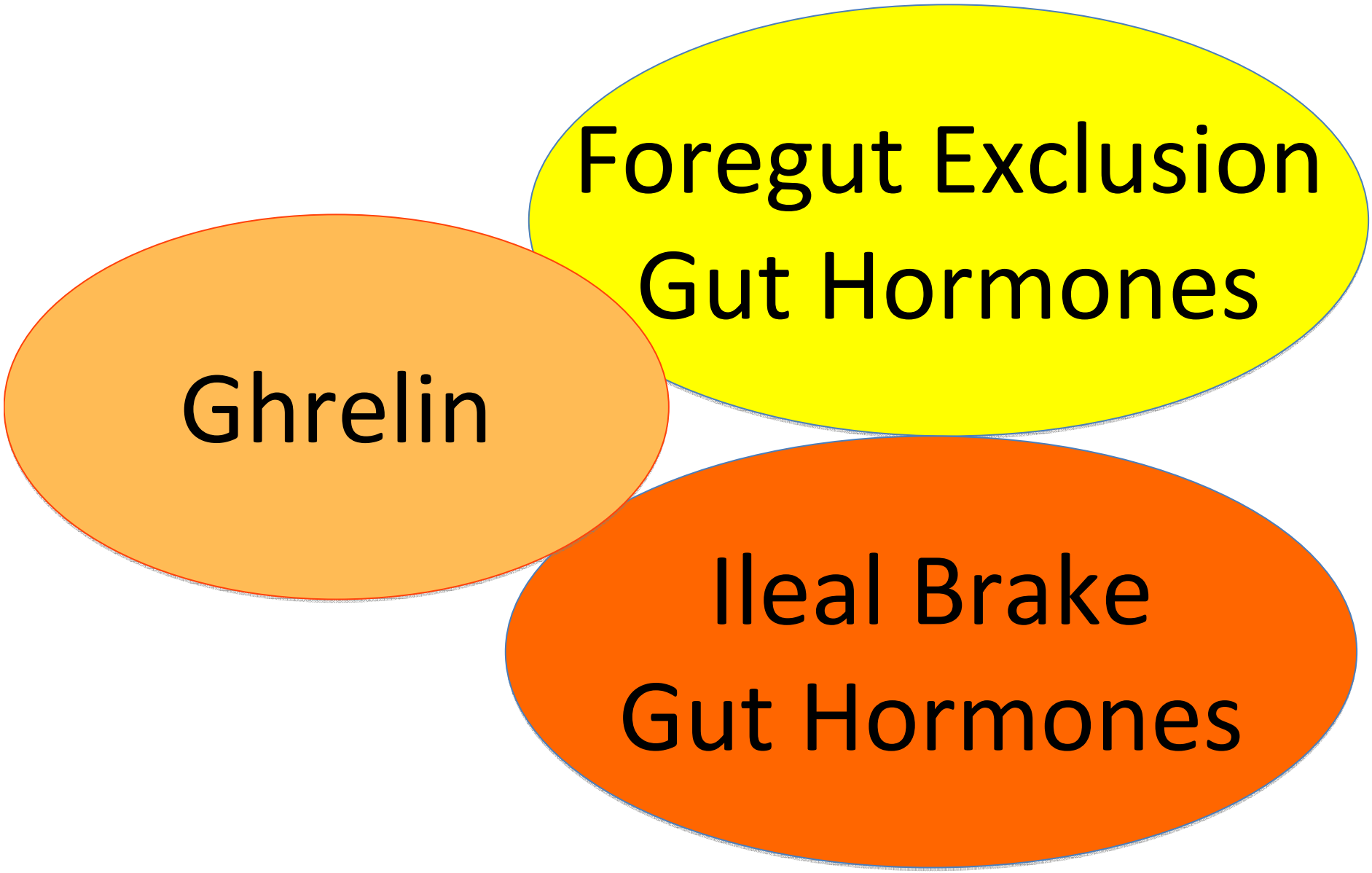


Evans S, Surg Endosc 2012

Caloric Restriction in the Early Improvements in Insulin Sensitivity After Roux-en-Y Gastric Bypass Surgery



Isbell JM. et al Diabetes Care 2010


Foregut Exclusion
Gut Hormones
Ghrelin
Ileal Brake
Gut Hormones

Reference	No./Surgery Control	Study/Follow-up	Peptides/Results
Christou [38]	36 RYGBP 8 Lean	C/S 3 y after	Ghrelin pm RYGBP < Lean Ghrelin pm not related to EWL or Satiety
Dixon [23]	17 AGB 17 Controls (BMI =)	C/S After ≥35% EWL	↑Ghrelin f/pm AGB Satiety f/pm > AGB Satiety not related to Ghrelin f/pm
Foschi [29]	12 VBG 6 Lean	L Before, after ↓ 20% BMI	Ghrelin f Pre VBG < Lean Ghrelin pm Pre VBG not suppressed ↑ Ghrelin f PO VBG Ghrelin pm VBG suppressed
Langer [22]	10 AGB 10 SG	L Before, 1 d, 1 and 6 mo after	↑ Ghrelin 1and 6 mo AGB ↓ Ghrelin 1 d, 1 and 6 mo SG
Ram [26]	23 AGB	L Before, 6, and 14 mo after	Ghrelin f ≈
Borg [10]	6 RYGBP	L Before,1, 3, and 6 mo after	≈ Ghrelin f/pm ↑ GLP-1, PYY, EG pm 3, 6 mo Satiety significantly better
Chan [21]	6 RYGBP 5 Lean 12 Obese	C/S 1.5 y after RYGBP	PYY f RYGBP = Obese = Lean ↑PYY pm RYGBP > Obese > Lean ↓ Ghrelin f and pm RYGBP< Obese < Lean
Christ-Crain [56]	8 AGB 5 RYGBP 7 Obese	L Before, 6, 12, and 24 mo after	↑ proNT/NMN f RYGBP ≈ proNT/NMN f AGB
Couce [11]	49 RYGBP 19 AbdS	L Before, 2 h, 10 d, 6 mo	Ghrelin f Pre RYGBP > AbdS ↓ Ghrelin f 2 h RYGBP and AbdS ↓ Ghrelin f 10 d RYGBP ($n = 18$) ≈ Ghrelin f 6 mo RYGBP ($n = 11$)
Guidone [43]	10 BPD (with DM)	L Before, 1, and 4 wk after	↓ GIP f/pm ↑ GLP1 f/pm
Knerr [28]	61 AGB 20 AGB BE 11 Lean fundoplication	C/S 29 mo after	Ghrelin f AGB < Lean Ghrelin f AGB = AGB BE
Korner [18]	9 RYGBP 9 AGB 8 Lean 11 Obese	C/S 15–35 mo after	PYYf and $PYY_{(3\text{-}36)}f$ RYGBP = AGB = Lean = Obese PYYpm and $PYY_{(3\text{-}36)}$pm RYGBP > AGB, Lean, Obese Total Ghrelin f RYGBP = AGB = Lean = Obese Oct Ghrelin f RYGBP, AGB, Obese < Lean Total and Oct Ghrelin pm RYGBP suppressed < Lean, Obese < AGB Satiety RYGBP > AGB
Kotiditis [30]	13 VBG 13 BPD-SD 14 on diet	L Before, 18 mo after	↑ Ghrelin VBG, on diet ↓ Ghrelin f BPD-SD

Kotiditis [31]	13 BPD-DS	L Before, 18 mo after	↓ Ghrelin f
Le Roux [19]	6 AGB 6 RYGBP 12 Obese 15 Lean	C/S 6 to 36 mo after	Ghrelin f Lean > RYGBP, AGB, Obese ↑ PYY pm RYGBP ↑ GLP1 pm RYGBP PP pm RYGBP = AGB = Obese = Lean
Mancini [12]	10 RYGBP	L Before, 6 mo after	≈ Ghrelin f ≈ 24 h profile Ghrelin
Mingrone [34]	6 BPD 6 Lean	L Before, 14 mo after	24 h profile Ghrelin Lean > Pre and PO ↑ 24 h profile Ghrelin BPD Ghrelin pulsatility decreased BPD
Morinigo [47]	9 RYGBP 6 Controls (BMI =)	L Before, 6 wk after	↑ GLP1pm ↑ PYYpm Satiety better
Morinigo [45]	34 RYGBP (10 with DM)	L Before, 6 wk, 12 mo after	GLP1 f ≈ ↑ GLP1 pm 6 wk, but not significant in diabetics ↑ GLP1 pm 12 mo No correlation GLP1 glucose homeostasis
Stratis [32]	20 BPD-RYGBP 13 colectomy	L Before, 1, 3, 7, 30, and 90 d after, 1 y (n = 10)	↓ Ghrelin f BPD-RYGBP 1, 3, 7 d ↑ Ghrelin f BPD-RYGBP 1 y ↑ PYY f BPD-RYGBP 90 d and 1 y
Korner [40]	10 AGB 13 RYGBP 13 Obese	C/S 15–36 mo after	↑ GLP1 pm RYGBP > AGB, Obese GIP pm RYGBP < AGB, Obese
Laferrère [49]	8 RYGBP (with DM) 7 Obese	L Before, 1 mo after	GLP1f, GIP f Pre RYGBP = Obese ↑ GLP1 pm RYGBP ↑ GIP pm RYGBP (peak)

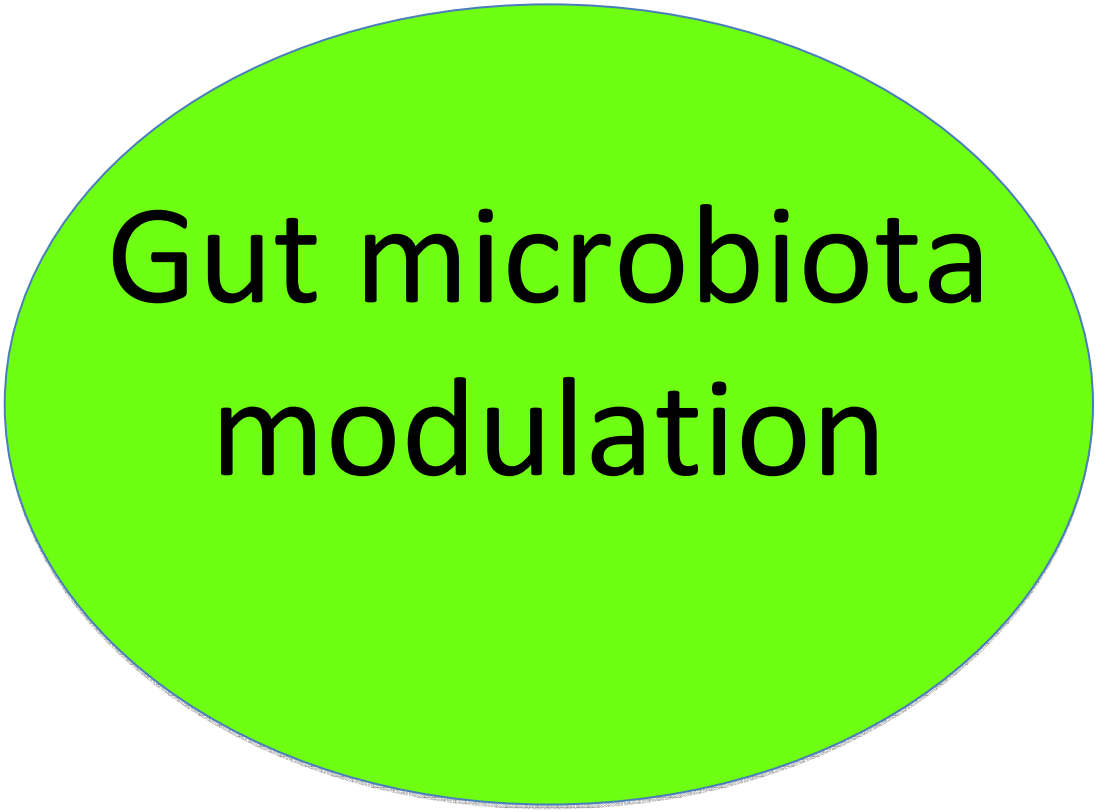
Bariatric surgery and the gut-brain communication: a review

Conclusion

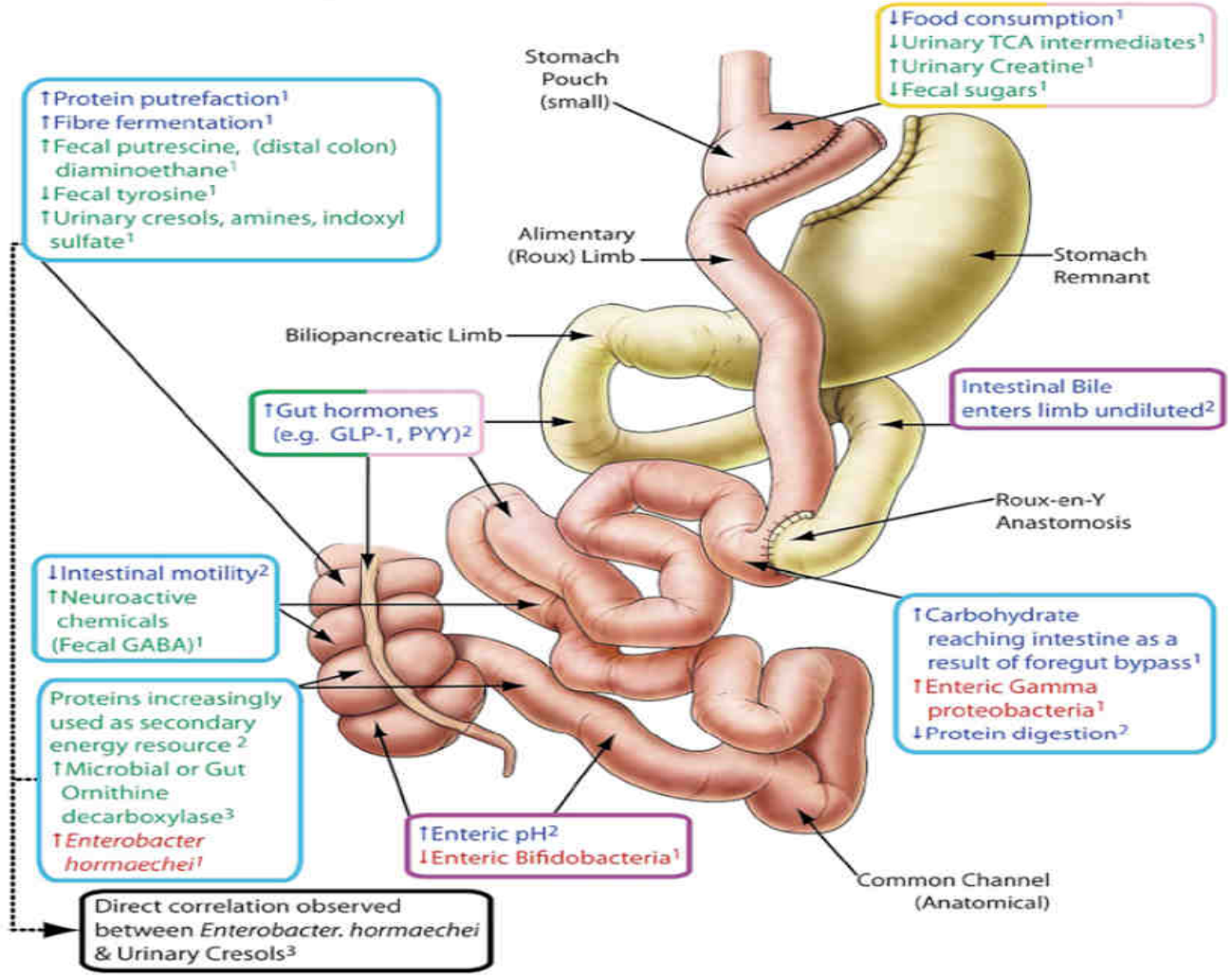
There is a lack of long-term data on gastrointestinal hormone profiles after bariatric surgery and their relationship with weight and comorbidity outcomes. Methodological aspects of the studies must improve. At the moment, it is not possible to draw an impressive conclusion on the gut peptide changes after bariatric surgery. We suspect that GLP1, GIP, and PYY alterations may contribute to the excellent results in glycemic control of diabetics. Ghrelin suppression has been linked to increased satiety, alterations in energy homeostasis, and better glucose metabolism, but further long-term studies are necessary because many controversies still exist regarding different operative techniques.

Satiety/appetite/energy homeostasis is a very complex network, and it is unlikely that one hormone alteration explains all the results of the operations. In fact, different surgical techniques may generate good results in weight loss, which are probably linked to diverse gastrointestinal and peripheral hormone alterations.

Diniz MS et al, Nutrition 2010

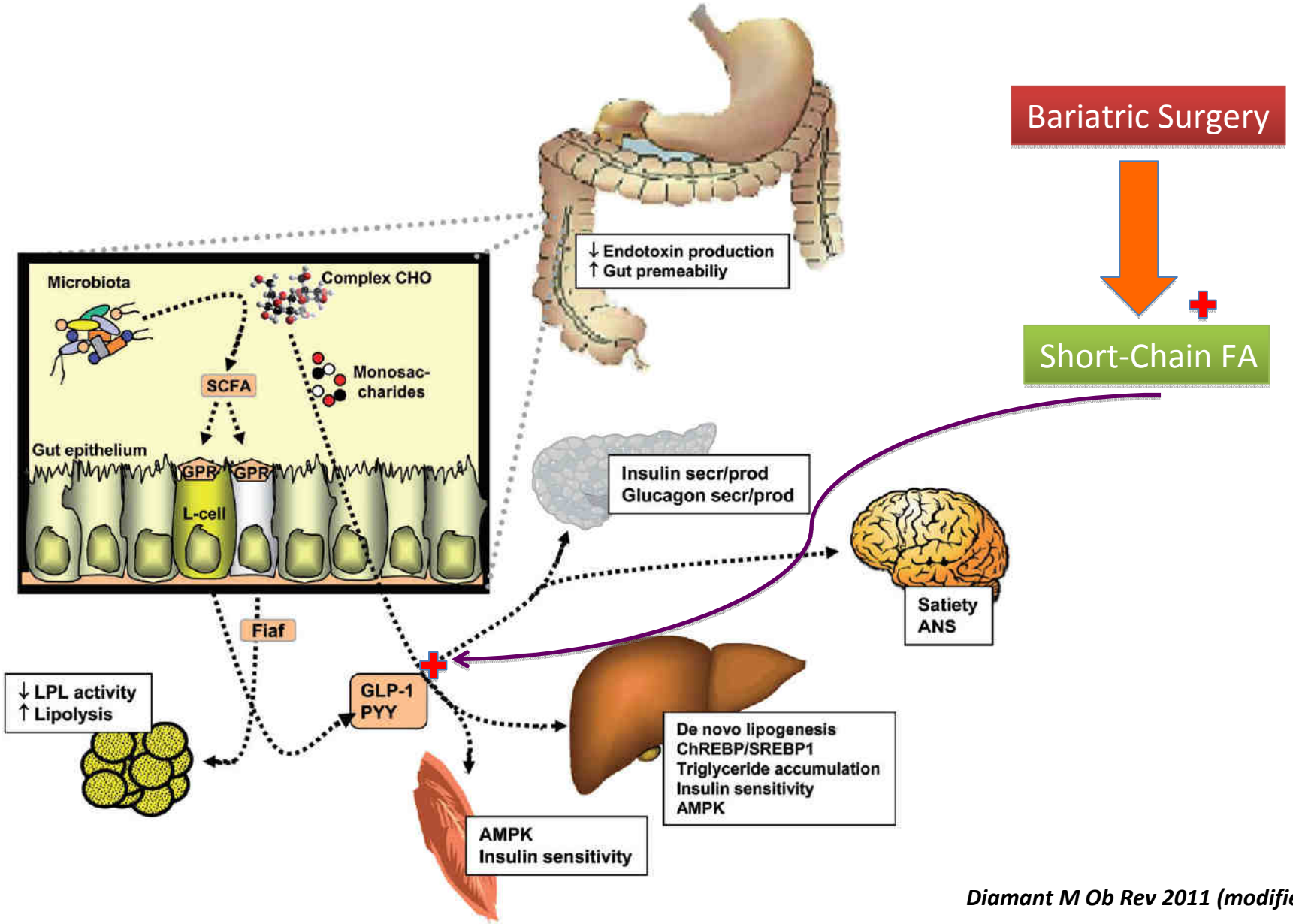

Gut microbiota
modulation

The Roux-en-Y Gastric Bypass in Relation to Physiological and Microbial Activities

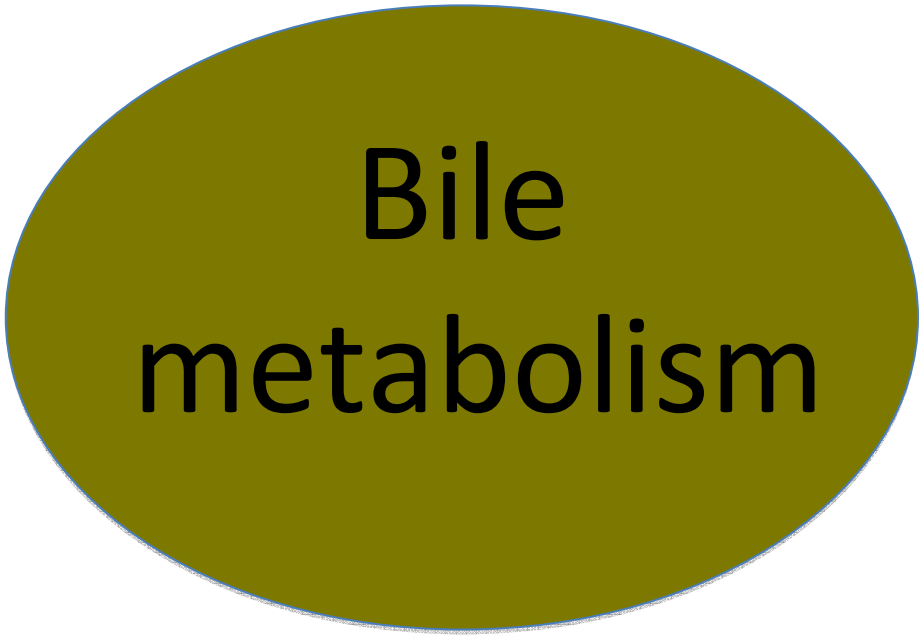


COLOR CODE KEY FOR BRAVE EFFECTS (Box outline)	LABEL KEY	TEXT COLOR KEY
B-Bile Flow alteration	1. Direct observation	Physiology
R-Reduction of gastric size	2. Literature	Biochemistry
A-Anatomical gut rearrangement and altered flow of nutrients	3. Hypothesis	Microbiology
V-Vagal manipulation		
E-Enteric gut hormone modulation		

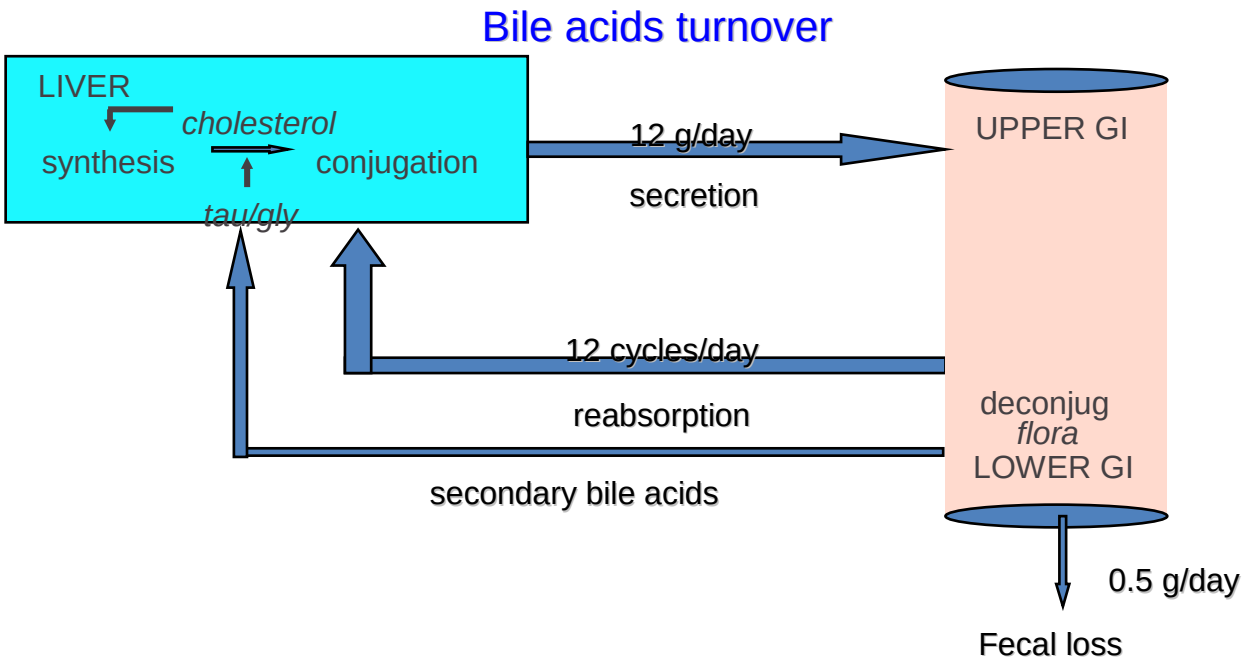
Do nutrient–gut–microbiota interactions play a role in human obesity, insulin resistance and type 2 diabetes?



Diamant M Ob Rev 2011 (modified)


Bile
metabolism

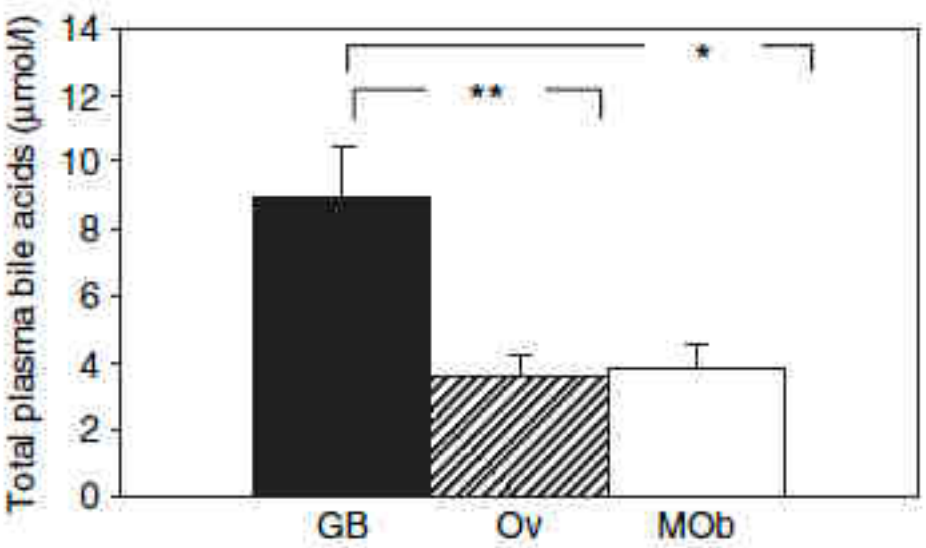
B= Serum Bile Acids

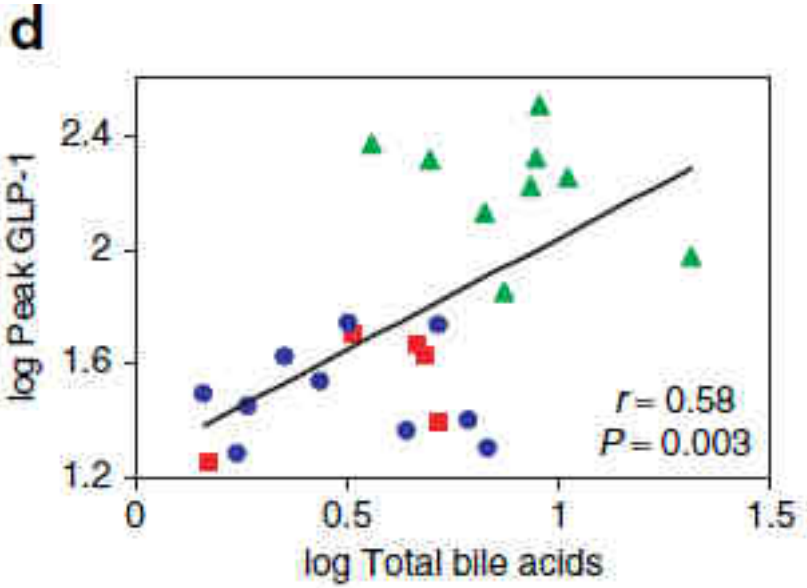


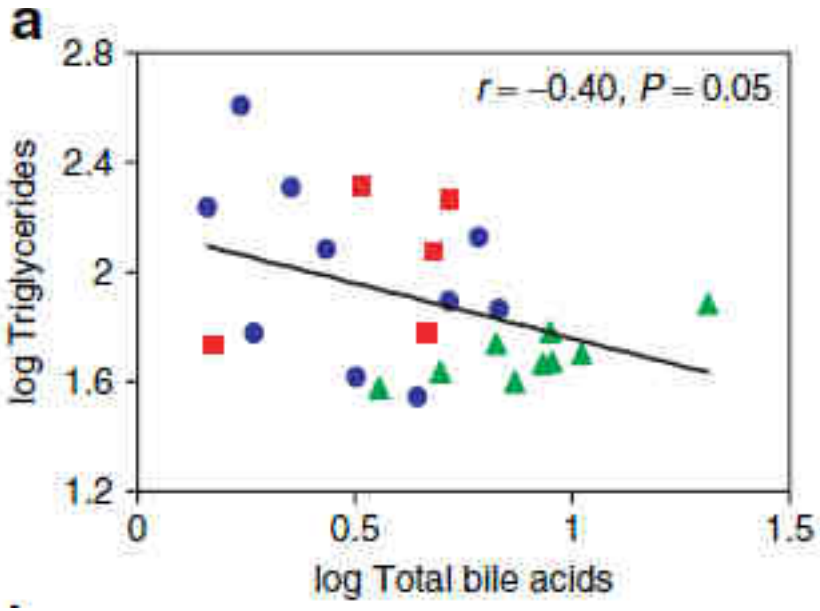
TGR5 (and PPAR?) activation by bile acids leads to:

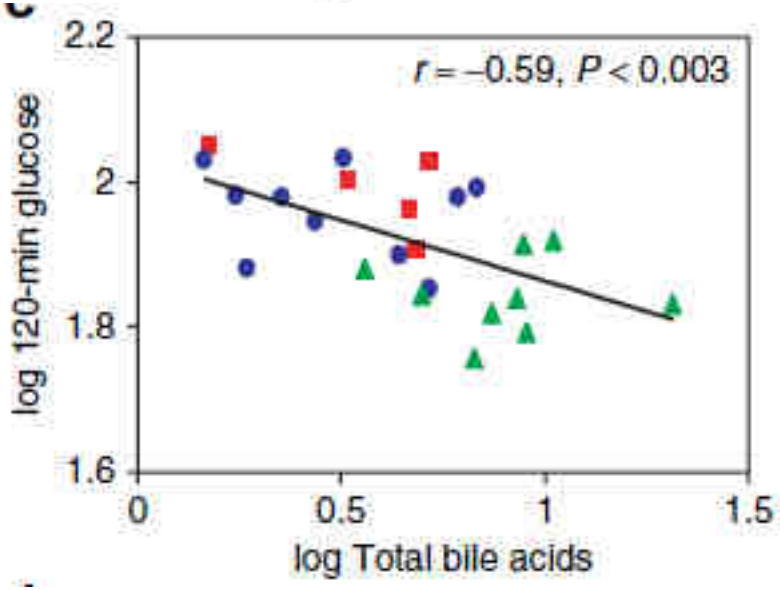
- Increase in the conversion from T_4 into T_3 (through DIO2)
- Increase in energy expenditure
- Improvement of insulin sensitivity
- Increase in release of GLP-1 and GIP (via c-AMP)

B= Serum Bile Acids:
Potential contribution to improve glucose metabolism









Patti ME. et al Obesity 2009

SUMMARY

▪The effects of bariatric surgery on diabetes are related to improvement or restoration of:

a.insulin sensitivity (weight loss in restrictive or mixed surgery);

b.insulin secretion (possibly due to modification of GI transit and neuro-endocrine factors and reduction of glucotoxicity and lipotoxicity).

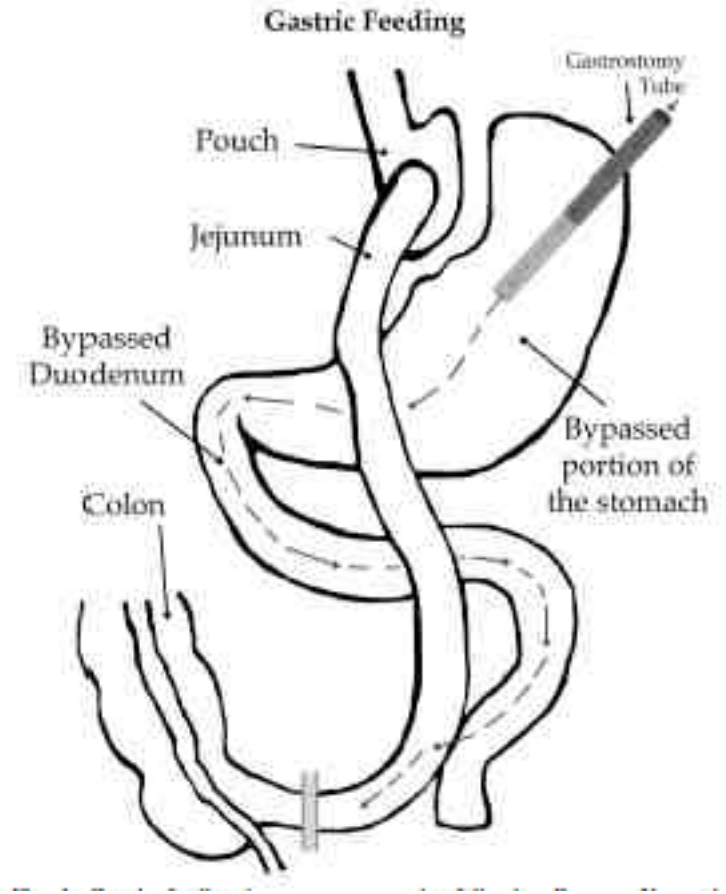
▪Rate of success of bariatric surgery in terms of diabetes remission may depend on the extent of β-cell dysfunction/loss at time of operation and, hence, could be lower for:

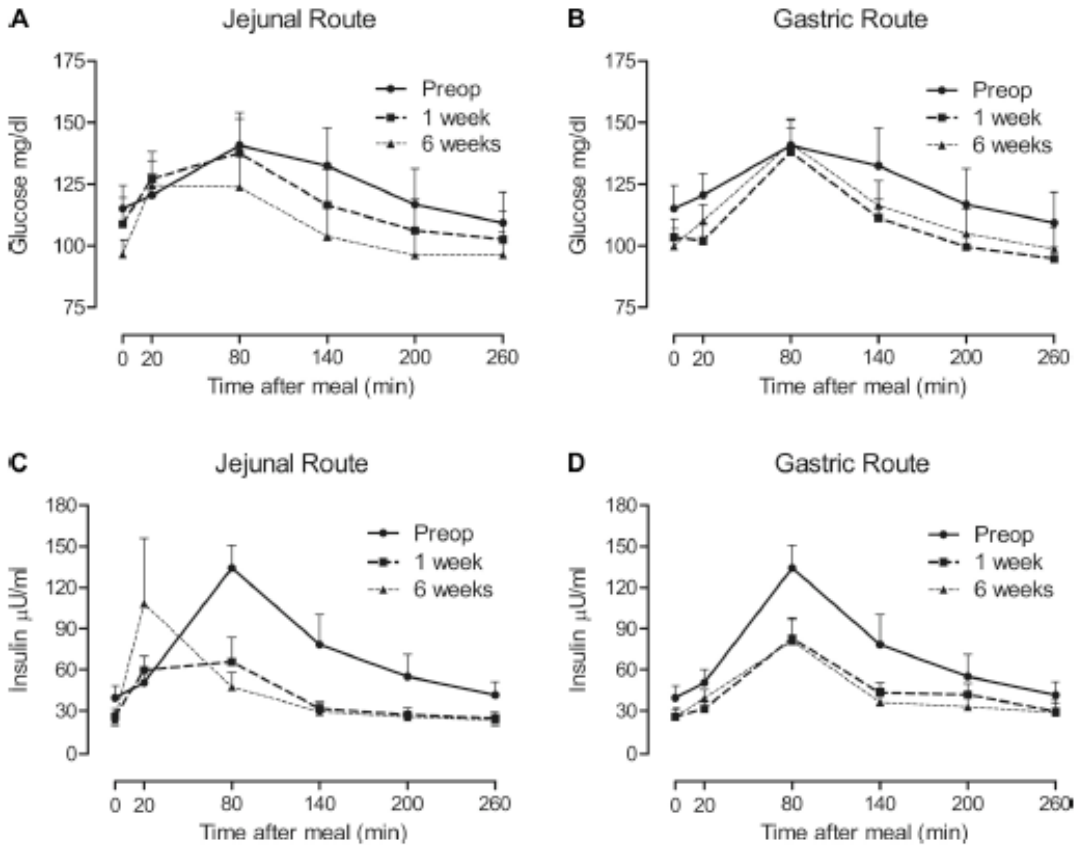
a.longer diabetes duration;

b.less severe degrees of obesity.

•Bariatric surgery is associated with a significant rate of short term and long term complications

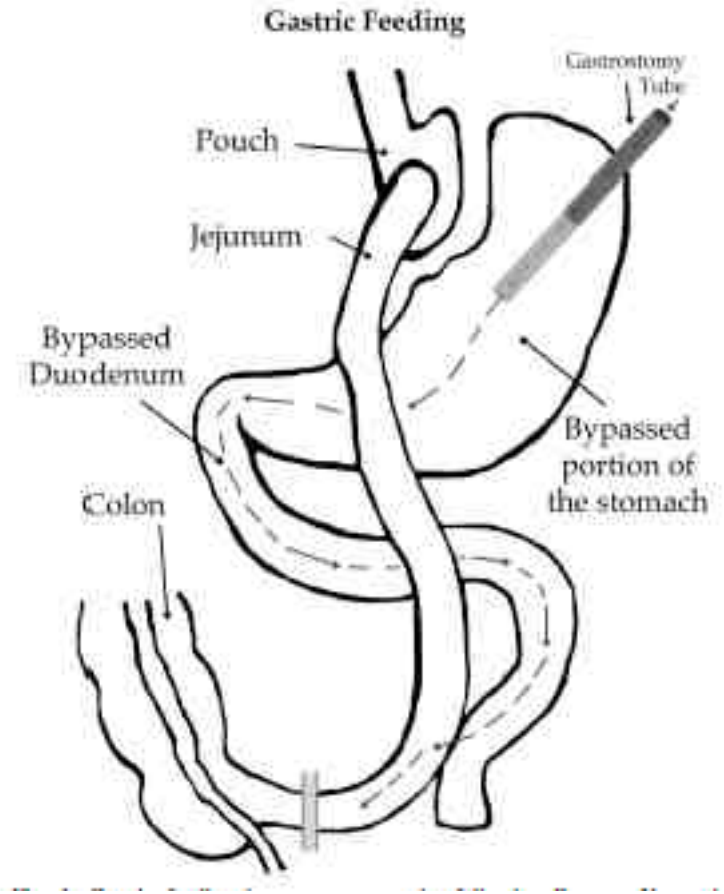
Role of the foregut in the early improvement in glucose tolerance and insulin sensitivity following Roux-en-Y gastric bypass surgery

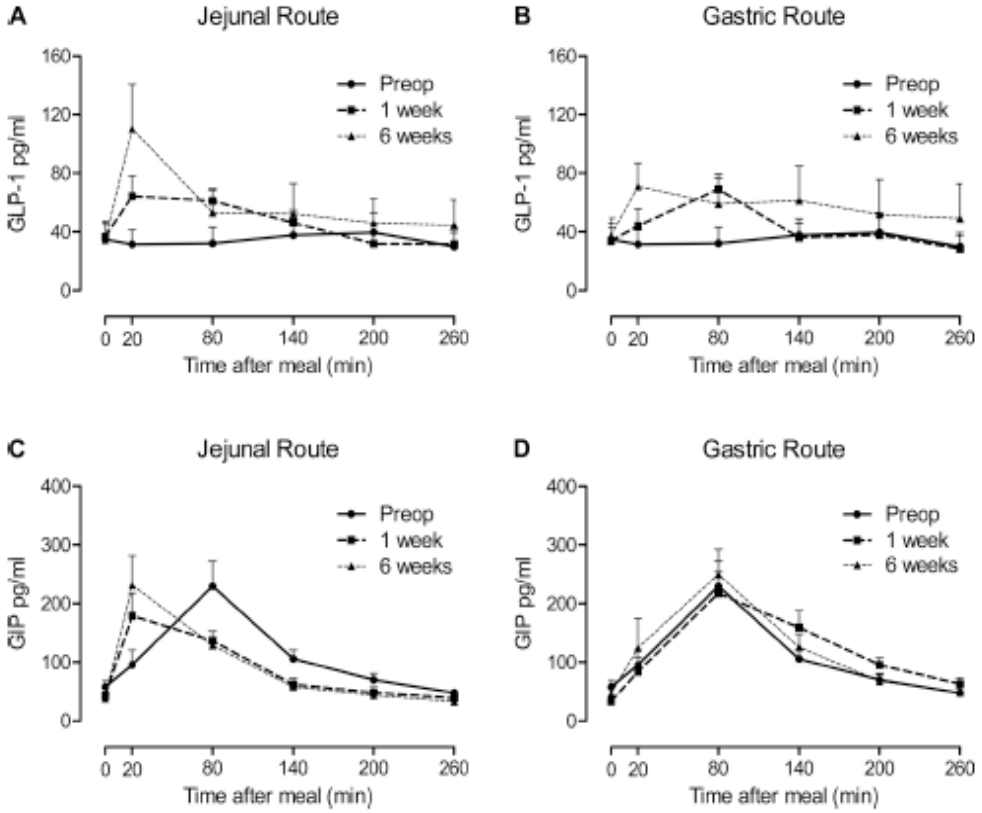




Hansen EN et al Am J Physiol 2011

Role of the foregut in the early improvement in glucose tolerance and insulin sensitivity following RYGBP

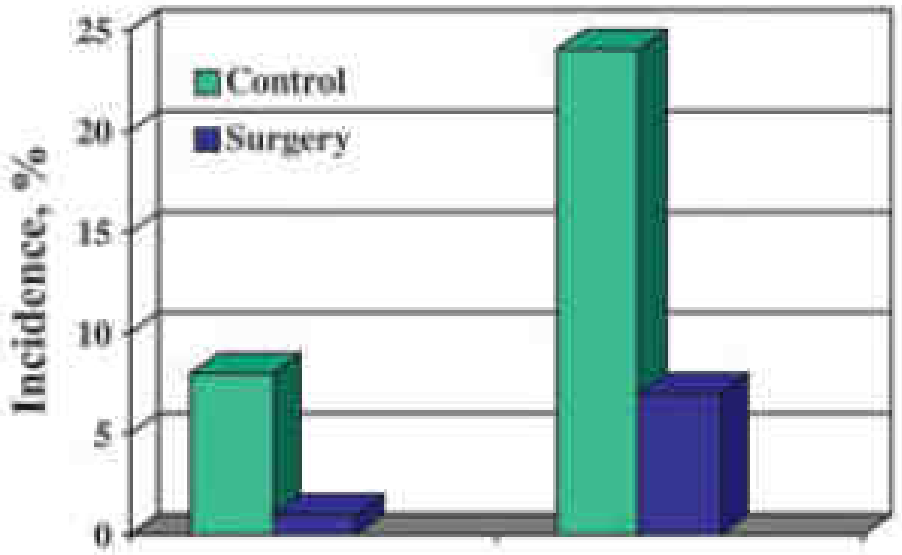




Hansen EN et al Am J Physiol 2011

Cumulative Incidence and Remission of T2DM

(b) SOS. Incidence of diabetes over 2 and 10 years



Number of subjects:	2 year	10 year
Control	1402	539
Surgery	1489	517
Adjusted Odds ratio	0.14	0.25
95% CI	0.08 - 0.24	0.17 - 0.38
P value	<0.001	<0.001

Sjostrom L, J Int Med 2012

Metabolic Surgery for type 2 diabetes with BMI<35 kg/m2
Randomized trials

Table 2
Randomized trials and meta-analysis of bariatric surgery trials including patients with body mass index <35 kg/m^2

Study	Type	BMI range	Procedure	N	Duration	Follow-up	Weight loss	BMI change	Health outcomes
O'Brien 2006 [30]	RCT	30–35	LAGB versus medical therapy	80	2 years	97%	87.2% EWL versus 21.8% EWL ($P < .001$)	33.7 to 26.4 versus 33.5 to 31.5 ($P < .001$)	Metabolic syndrome 38% to 3% ($P < .001$) versus 38% to 24% (N.S.)
Dixon 2008 [28]	RCT	30–40	LAGB versus medical therapy for T2DM	60	2 years	92%	20.7% TWL versus 1.7% TWL ($P < .001$)	36.9 to 29.5 versus 37.1 to 36.6 ($P < .001$)	Remission of diabetes: 22 of 30 (73%) versus 4 of 30 (13%)
Lee 2011 [29]	RCT	25–35	MGB versus LSG	60	1 year	100%	MGB 94% EWL LSG 76% EWL	MGB 30 to 22.8 LSG 30 to 24.4	HbA_{1c} MGB 9.9% to 5.4% LSG 10.2% to 7.2% Higher rates of remission for MGB compared with LSG
Schauer 2012 [5]	RCT	27–43 (34% of patients with BMI <35)	LRYGB versus LSG versus IMT for T2DM	150	1 year	93%	LRYGB 88% EWL LSG 81% EWL IMT 13% EWL ($P < .001$ surgical groups compared with IMT)	LRYGB –10.2 LSG –8.9 IMT –1.9 ($P < .001$ surgical groups compared with IMT)	% of patients with HbA_{1c} <6.0: LRYGB 42% LSG 37% IMT 12% ($P < .008$ surgery versus IMT); significant reduction in cardiovascular medication in surgery groups versus IMT
Li 2012 [47]	Meta-analysis	<35 with T2DM	RYGB (4 studies) DJB (3 studies) BPD (3 studies) MGB (2 studies) SG (1 study)	357 (13 studies)	6 months to 18 years (mean 27 months)	NR	–17 kg ($P < .0001$)	–5.8 ($P < .0001$)	FPG –4.4 mmol/L HbA_{1c} –2.59% Triglycerides –56.7 mg/dL Total Cholesterol –48.4 mg/dL (All changes $P < .01$)

BMI = body mass index; RCT = randomized controlled trial; T2DM = type 2 diabetes mellitus; LAGB = laparoscopic adjustable gastric band; LSG = laparoscopic sleeve gastrectomy; IMT = intensive medical therapy; LRYGB = laparoscopic Roux-en-Y gastric bypass; RYGB = Roux-en-Y gastric bypass; DJB = duodenal-jejunal bypass; BPD = biliopancreatic diversion; N.S. = not significant; MGB = mini-gastric bypass; SG = sleeve gastrectomy; NR = not reported; EWL = excess weight loss; TWL = total weight loss; FPG = fasting plasma glucose; HbA_{1c} = glycated hemoglobin.

ASMBS Clinical Issue Committee, Surg Obes Rel Dis 2013