



# THE REVERSAL OF TYPE 2 DIABETES FOLLOWING GASTRIC BYPASS SURGERY: POTENTIAL MECHANISMS

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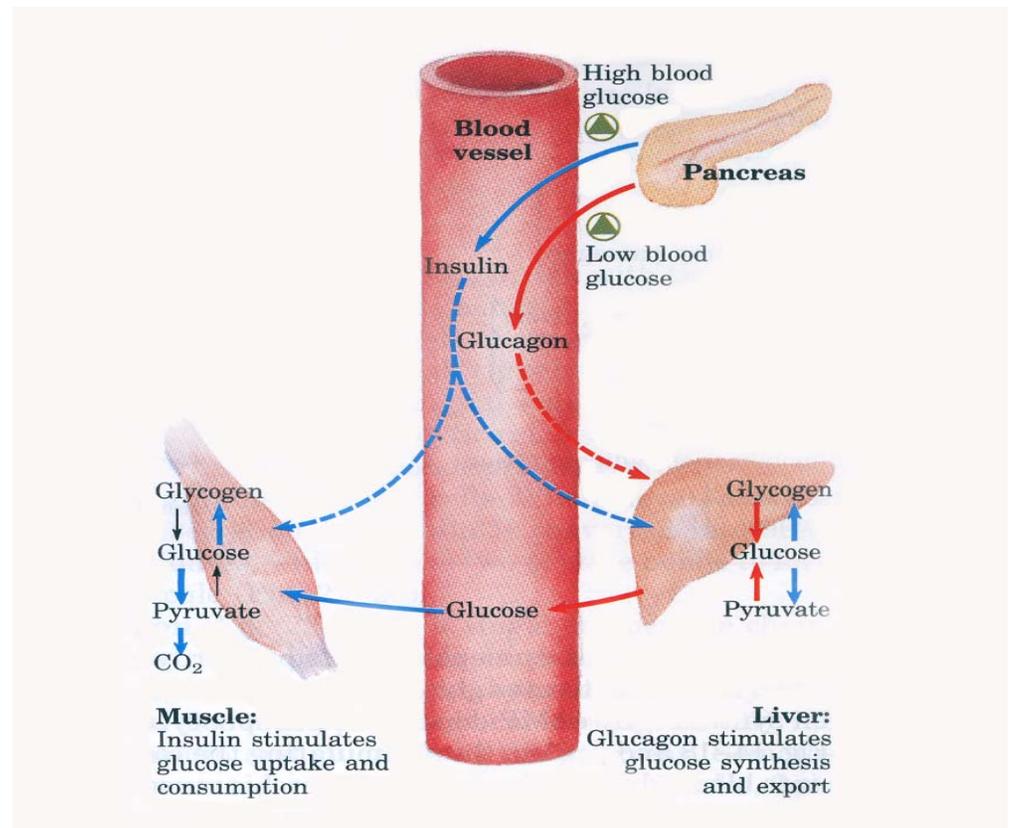
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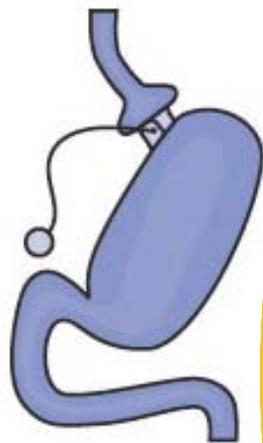
Department of Kinesiology

# Overview

- Bariatric Surgery
- Roux-en-Y Gastric Bypass (RYGB)
- Long term outcomes of RYGB
- RYGB and Type 2 Diabetes?
- Glucose and Insulin response post-RYGB



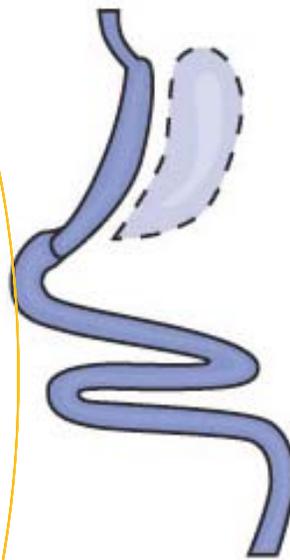
# Different kinds of Bariatric Surgery



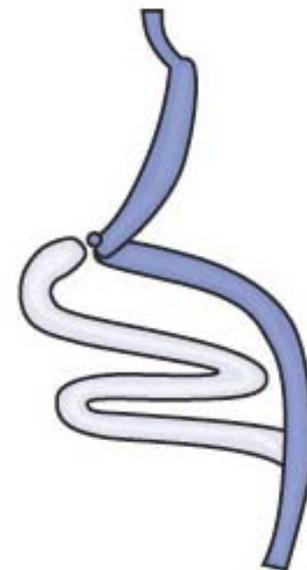
Adjustable  
Gastric Band  
(AGB)



Roux-en-Y  
Gastric Bypass  
(RYGB)



Vertical Sleeve  
Gastrectomy  
(VSG)



Biliopancreatic  
Diversion With a  
Duodenal Switch  
(BPD-DS)

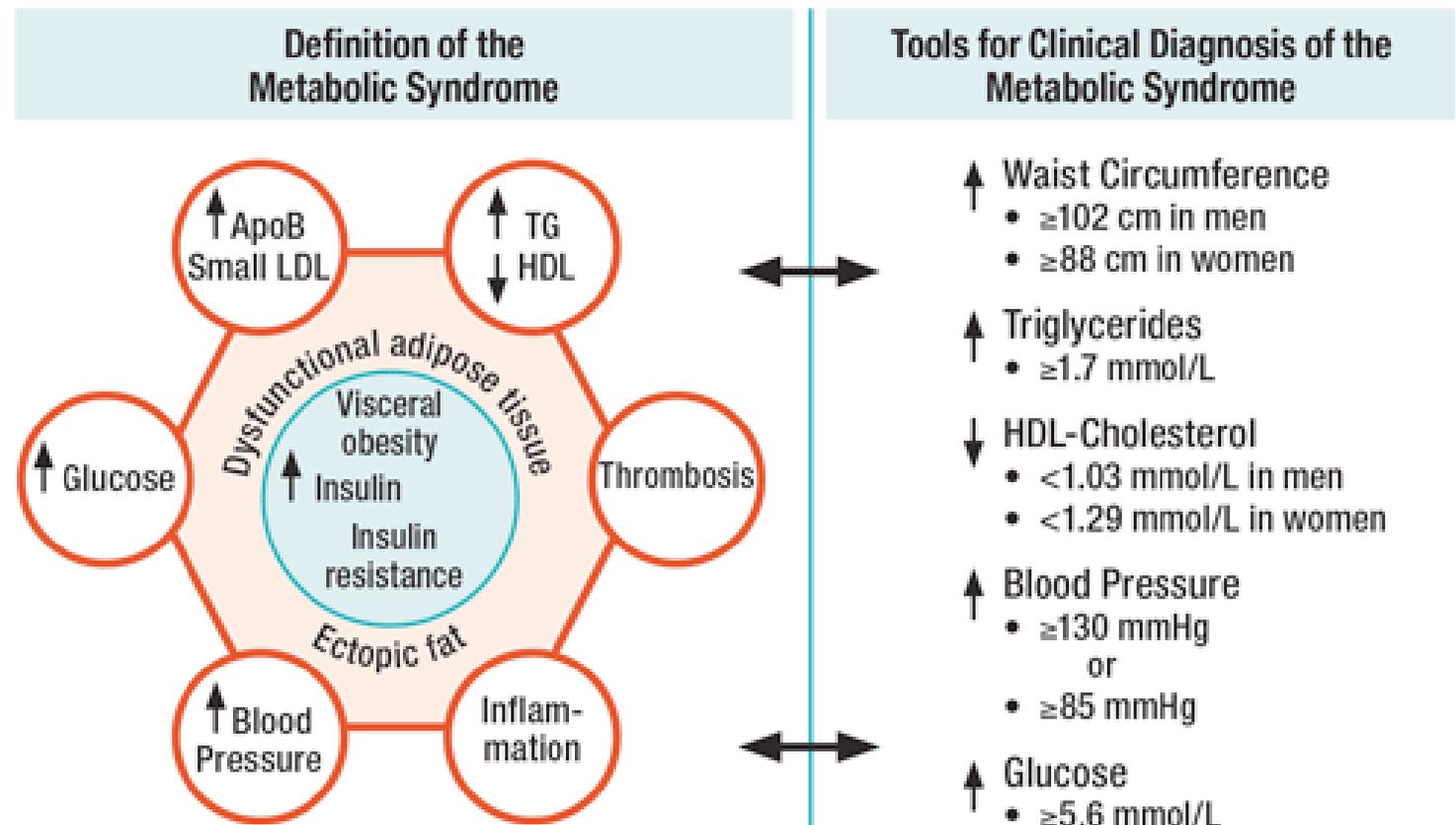
***Weight Loss After Gastric Bypass  
@ 16 Years (ECU; n=831; 95% Followup)***

	<b>Mean Weight</b>	<b>Mean % XS Weight Loss</b>	<b>Mean BMI</b>
<b>Preop</b>	<b>317</b>	<b>0</b>	<b>51</b>
<b>1 year</b>	<b>199</b>	<b>67</b>	<b>32</b>
<b>2 years</b>	<b>194</b>	<b>69</b>	<b>32</b>
<b>5 years</b>	<b>209</b>	<b>57</b>	<b>34</b>
<b>10 years</b>	<b>217</b>	<b>51</b>	<b>35</b>
<b>16 years</b>	<b>211</b>	<b>55</b>	<b>37</b>

***106 lb***

# Effects of RYGB

- RYGB is a metabolic surgery – not just a weight loss surgery



## Metabolic Effects of RYGB (Diabetes resolution)

### Comorbidity Resolution According to Procedure

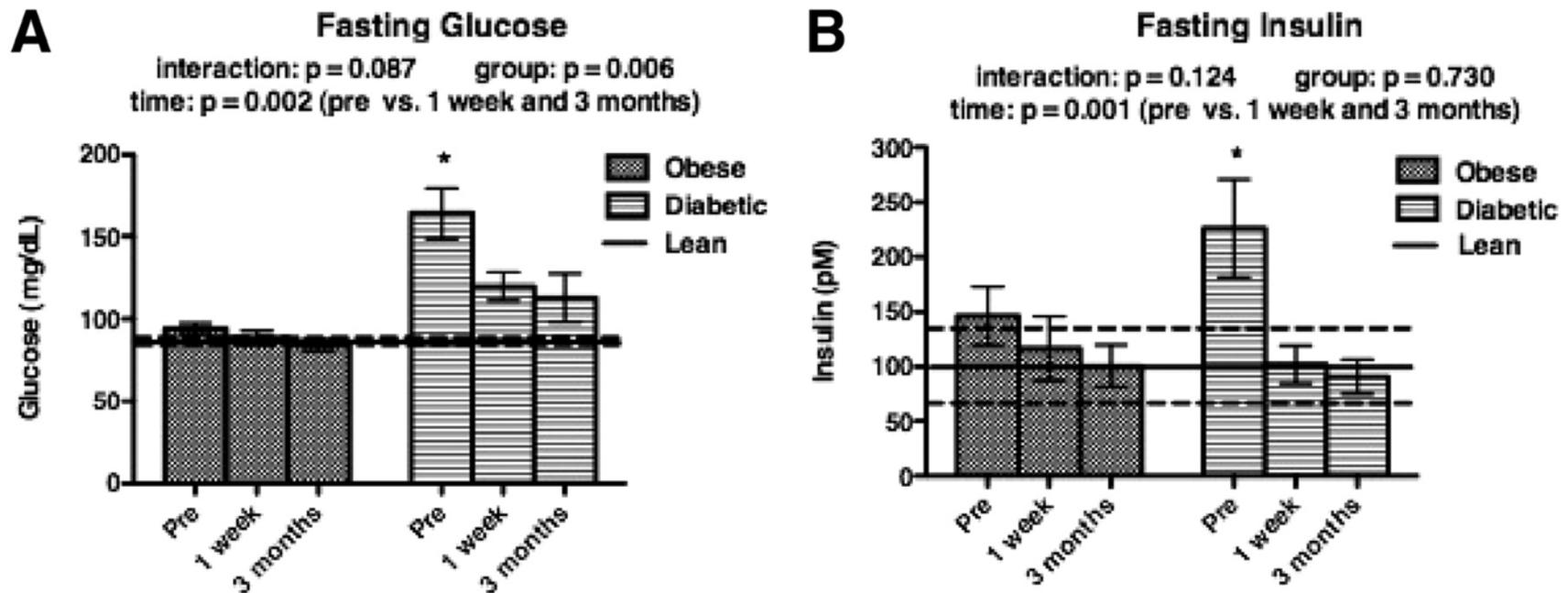
	Gastric Banding	Gastroplasty	Gastric Bypass	BPD or DS	Total
<b>EWL</b>	47%	68%	62%	70%	61%
<b>Mortality</b>	0.1%		0.5%	1.1%	NR
<b>Resolution of DM</b>	48%	72%	84%	99%	77%
<b>Resolution of Hyperlipidemia</b>	59%	74%	97%	99%	79%
<b>Resolution of Hypertension</b>	43%	69%	68%	83%	62%
<b>Resolution of Sleep Apnea</b>	95%	78%	80%	92%	86%

Buchwald et al. *JAMA*. 2004;292:1724-1737

# Our study

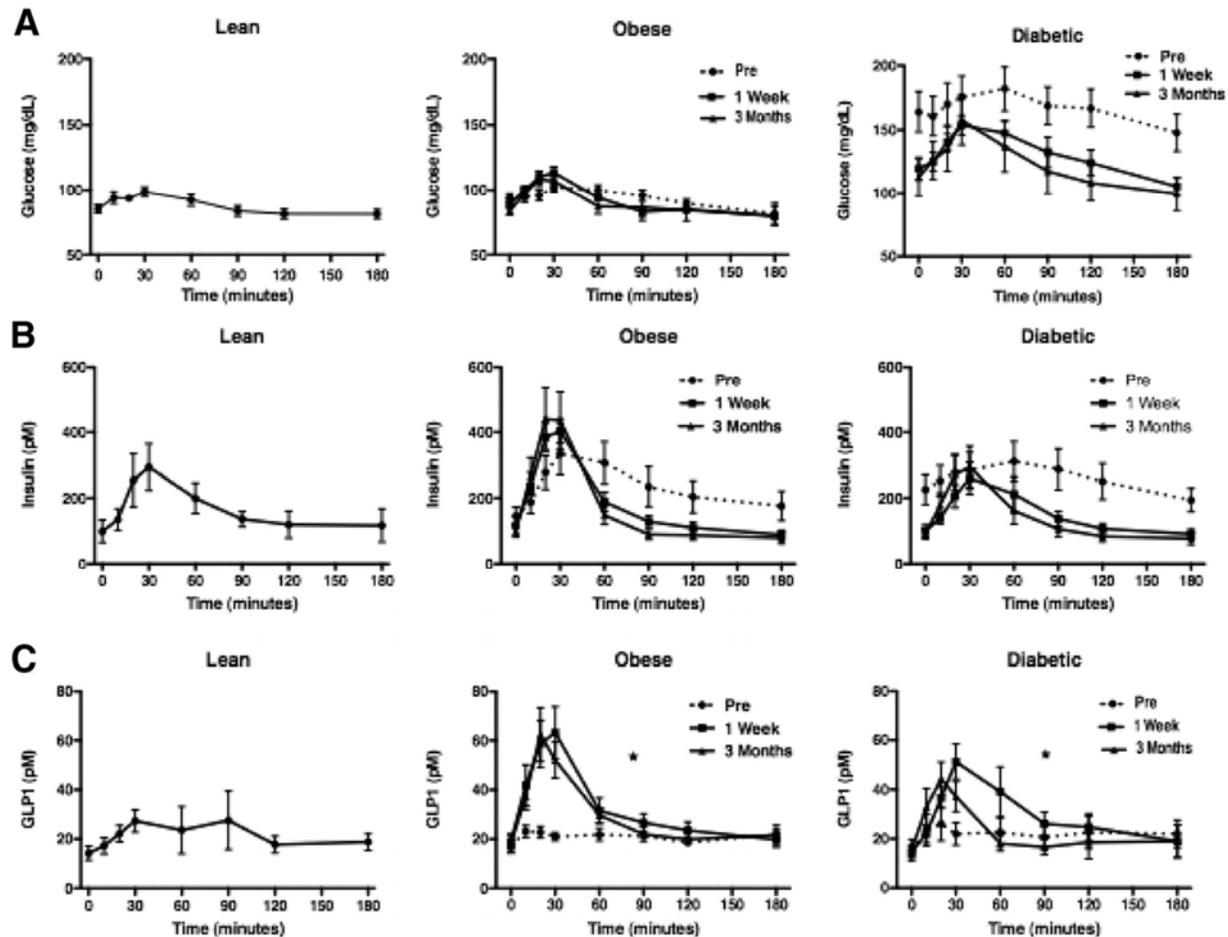
- Purpose
  - Examine changes in insulin sensitivity and insulin secretion to identify potential mechanisms for the reversal of Type 2 Diabetes following RYGB
- Groups and time points
  - Lean control (no surgery), obese (surgery), type 2 diabetes (surgery)
  - 1 week prior to surgery, 1 week post surgery, 3 months post surgery
- n =27 (9 in each group)
- Metabolic testing
  - Mixed meal test (MMT)
  - Intravenous glucose tolerance test (IVGTT)
- What was measured
  - MMT- glucose, insulin and GLP-1
  - IVGTT – glucose, insulin, insulin sensitivity, beta cell function (AIRg)

# Fasting Glucose and Insulin



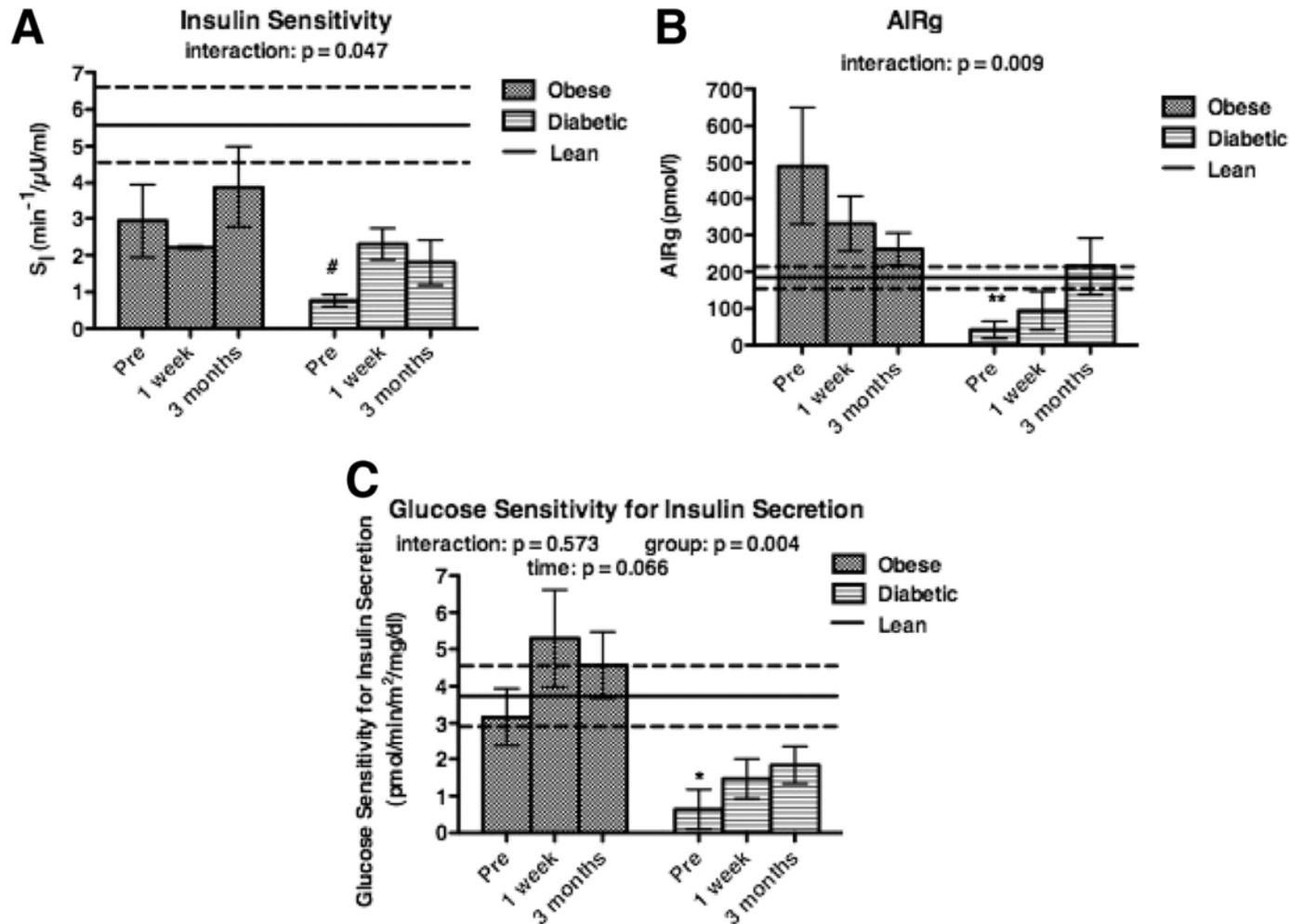
Fasting glucose (A) ( $n = 9$  lean,  $n = 8$  obese and type 2 diabetes) and insulin (B) ( $n = 8$  lean,  $n = 8$  obese and type 2 diabetes) before surgery and 1 wk and 3 months after surgery. The mean  $\pm$  sem for the lean control group is represented by the solid and dashed lines. \*, Significantly different from lean and obese before surgery.

# Glucose, Insulin and GLP-1 in response to a mixed meal



Changes in glucose (A), insulin (B), and GLP-1 (C) in response to a mixed-meal tolerance test in lean, obese (before surgery, 1 wk after surgery, and 3 months after surgery) and diabetic (before surgery, 1 wk after surgery, and 3 months after surgery) subjects. \*, Presurgery area under the curve significantly different from 1 wk and 3 months after surgery. For lean patients, n = 9 in all datasets. Presurgery obese n = 9 with the exception of GLP-1, n = 6. At 1 wk after surgery, obese n = 9 for all except GLP-1, n = 8. At 3 months after surgery, obese n = 8 with the exception of GLP-1, n = 7. For all measurements in the type 2 diabetes, n = 9 before surgery and 1 wk after surgery, and n = 8 3 months after surgery.

# Glucose and Insulin response(s) to an IVGTT



A and B,  $S_1$  (A) and AIRg (B) in lean, obese, and diabetic patients before surgery and 1 wk and 3 months after surgery in response to an IVGTT; C, glucose sensitivity (C) in lean, obese, and diabetic patients before surgery and 1 wk and 3 months after surgery in response to a mixed meal. \*, Significantly different from lean and obese before surgery; #, significantly different from lean before surgery; \*\*, significantly different from obese before surgery. The mean  $\pm$  sem for the lean control group is represented by the solid and dashed lines.

# Take home points from this study

- Insulin sensitivity and insulin secretion increased one week post – RYGB in the patients with Type 2 Diabetes
- However, it did NOT appear that these changes are responsible for the reversal of Type 2 diabetes following RYGB for the following reasons
  - Insulin sensitivity in the patients with diabetes was increased post surgery, yet was still only ~50% that of the lean controls
  - Insulin secretion, while increased, was also not normalized in the patients with diabetes post-RYGB
  - Glucose sensitivity after a meal was still lower in the patients with diabetes compared to both groups
- Where do we go from here?



**THANK YOU!**

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