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

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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)

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

**106 lb**
Effects of RYGB

- RYGB is a metabolic surgery – not just a weight loss surgery
## Comorbidity Resolution According to Procedure

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

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 (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 ± 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 AlRg (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 ± 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!