Do fat and protein affect post prandial glycemia in the outpatient real world setting?

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Objectives

• Understand the effect of fat and protein on glycemic excursion in the post-prandial period in experimental and outpatient setting.

• Recognize the need for research dedicated to understand insulin dosing for fat and protein.
Disclosure

None
Macronutrients

- Carbs
- Proteins
- Fats

Meal time insulin dosing

- Mainstay is carbohydrate counting.
- Dose is individualized.
- But what about fat and what about protein?
- Does it have any effect on blood glucose (BG)?
Different types of Insulin boluses

- Even though only carbohydrate counting is used, there are different methods of insulin delivery
  - Depends on type of food; pizza, pasta, Mexican, Chinese.
  - However no clear guidelines available

**Normal Bolus**
- The bolus amount delivers as soon as the button is pressed.
- Primarily used for meals that contain average fat and carb content.
- Also used to deliver correction boluses.

**Square Wave Bolus**
- The bolus amount delivers evenly over the period of time you set.
- Primarily used by those who have delayed digestion (gastroparesis).
- Can also be used when eating small amounts of carb over an extended period of time, such as at receptions or parties.
- Can be set in 30 minute increments from 30 minutes up to 8 hours.

**Dual Wave Bolus**
- The bolus amount is split. Part of the bolus delivers as soon as the button is pressed (Normal) and the remainder delivers evenly over the period of time you set (Square Wave).
- Primarily used for meals that are both high in carbs and fat, which may delay digestion (for example pizza, Chinese or Mexican food).
- Percent you set to deliver now and as a Square Wave bolus will vary based on the meal content.

Medtronic Quick Reference Guide, accessed July 2018
How does protein affect post prandial glucose?

• Paterson et. al in 2016 conducted a study with pure protein shakes.

• Methods
  • 27 T1D patients (7-40yo) on CSII or MDI using CGM
  • Protein loads: 0, 12.5, 50, 75, 100 grams
  • Monitoring response for 300 mins after the meal

Paterson et. al, 2016
Results

post prandial glucose excursion after various protein doses

- Glycemic excursion did not statistically differ between 12.5 vs 25 and 50 grams of protein.

- Glucose levels were high during 240-300 min for 75g and 100g of protein similar to the 20g of CHO in the first 60 mins (p<0.05)

- Therefore delay in peak of BG

Paterson et. al, 2016
Conclusion

• Protein alone can increase post prandial glucose, when >75 grams consumed.

• Causes late and sustained hyperglycemia starting at 3 hours and continues beyond 5 hours.

• 75 grams of protein is:
  • 12oz grilled steak
  • 2.3 cups of peanuts (double fat)
  • 5 slices of Domino’s cheese pizza (also has 75 grams of fat)
  • 3.5 Ensure Enlive (high protein drink)

Paterson et. al, 2016
How does fat affect BG?

• High FFA impair glucose tolerance.
  • Competes with glucose for oxidative metabolism
  • Inhibits some steps of insulin action peripherally on muscles
  • Augments basal hepatic gluconeogenesis

• Many studies conducted to assess post prandial BG with fat ingestion in mixed meals

Bajaj et. al, 2004
# Fat and protein meal tests

<table>
<thead>
<tr>
<th>Group</th>
<th>Population</th>
<th>CHO (g)</th>
<th>Protein (g)</th>
<th>Fat (g)</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>McDonald et al, 2009</td>
<td>Adults (27) T1D</td>
<td>60 low GI 60 high GI</td>
<td>27 29 36 32</td>
<td>8 3 16 24</td>
<td>-Delayed peak of BG at 180 mins for all but low fat meal.</td>
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<tr>
<td></td>
<td>180 mins 4 meals</td>
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<td></td>
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<tr>
<td>Wolpert et al, 2011</td>
<td>Adults (7) T1D</td>
<td>constant</td>
<td>constant</td>
<td>10 60</td>
<td>35-40% increase in need for insulin in HF</td>
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<tr>
<td>Smart et al, 2013</td>
<td>Peds (33) T1D</td>
<td>30 30 30 30</td>
<td>40 5 40 5</td>
<td>35 35 4</td>
<td>- HFHP meals highest BG after 180mins</td>
</tr>
<tr>
<td></td>
<td>300 mins 4 meals</td>
<td></td>
<td></td>
<td></td>
<td>- HF and HP similar BG after 120 mins</td>
</tr>
</tbody>
</table>
Postprandial BG after fat ingestion

• High fat meal delays gastric emptying.
• In the immediate post-prandial period reduced BG noted compared to the rise seen with CHO ingestion.
• Rise in BG 90-180 minutes post prandial.
• Some studies showed 35g of fat increased BG by 40mg/dL (15)
• Some studies showed 50g of fat increase insulin requirement by 2-fold. (19)
• No dose response studies available to our knowledge.

Bell et. al, 2015
Questions remaining

- How much fat is too much? Dose response?
- How much protein is too much when combined with fat?
- Is this protein and fat effect noted in the outpatient setting in daily life?
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Study overview

**Recruited** T1D patients that met the inclusion and exclusion criteria

Review their pump downloads to ensure reasonable control.

**Data collection**
21 meals and post prandial glucose for 4 patients

**Data analysis**
Inclusion criteria

• T1D for at least 2 years
• CSII >1 years
• A1c <9%
• BMI 18-27
Exclusion criteria

- Steroid use
- GI conditions, example: celiac
- Gastroparesis
- Eating disorders
- Other DM medications
Methods

Number of patients: 5 patients recruited.

Duration: 3 weeks

Meals: 7 breakfast, 7 lunch and 7 dinner meals.

- Record pre-meal and 4-6 hours post meal finger stick glucose.
- Record meal contents on MyFitnesspal phone application.
Meal exclusion criteria

• Snack after the meal but before the 4-6 hours post prandial period.
• Alcohol use with the meal or in the post prandial period.
• Exercise before or after the meal.
• Use of complex insulin bolus.
Macronutrients in the study meals

- **Carbohydrates**: 21 - 141 grams; 16-83%
- **Protein**: 4-68 grams; 7-50%
- **Fat**: 1-63 grams; 7-56%

- Total 84 meals had complete data and used for analysis.
Bivariate fit of glucose by % fat in a meal

(p-trend = 0.011)
Results

• A linear relationship was noted with increase in BG 4-6 hour post meal period in response to increase in percentage of fat in a meal.

• A similar pattern was not noted with increasing amounts of protein.
  • Possibly because none of the study meals have protein >75grams to show an effect.
  • Another reason can simply be due to a small data set.
Questions remaining

• How much fat is too much? Dose response?
• How much protein is too much when combined with fat?
Clinical implications

• Determining the cut off for ‘high’ fat content may help the clinician to guide the patient on use a dual wave or a square wave bolus depending on the meal composition.

• Minimize guessing which meal requires a varied bolus or higher dose of insulin.
References

- Bajaj M, Suraomnukul S, Kashyap S, Mandarino L, DeFronzo RA. Sustained reduction in plasma free fatty acid concentration improves insulin action without altering plasma adipocytokine levels in subjects with strong family history of type 2 diabetes. J Clin Endocrinol Metab 2004; 89:4649–4655
- https://www.hsph.harvard.edu/nutritionsource/healthy-eating-plate/ Accessed January 28, 2018
- Medtronic. Dual/Square Wave quick reference guide for the paradigm revel insulin pump. Accessed Jan 28, 2018
Thank you