Baked Milk & Baked Egg Food Challenges

Teri Holbrook, CRNP
Kim Mudd, RN, MSN, CCRP
Johns Hopkins School of Medicine
Division of Pediatric Allergy/Immunology

Intro-Scope of the Problem

• Cow's milk allergy is most common childhood food allergy
• Children can outgrow milk allergy, but many will not become tolerant until later in life.
• Egg allergy is 2nd most common childhood food allergy
• Children outgrow egg allergy later and egg allergy persists into adolescents.

Scope of Problem - Quality of Life

• Current management of food allergy includes strict allergen avoidance and a clear plan to treat reactions as they occur
• The vigilance to maintain strict food avoidance plus the risk of accidental exposure results in impaired quality of life for patients and their families

Strict Avoidance vs Small Exposure

• Strict avoidance based on assumption that lack of exposure will lead to "deletion of immunologic memory".
• Clinical observations
  - Accidental ingestions don’t appear to delay tolerance development
  - Children who fail Oral Food Challenges (OFCs) go on to develop tolerance
  - Accidental and purposeful exposures to egg don’t appear to influence development of tolerance.

Background on Baked Milk

• Baking milk protein reduces the allergenicity – Loss of conformational epitopes?
• 100 known milk allergic children underwent heated milk OFC
  - 66% tolerated heated milk
  - These heated-milk tolerant subjects has smaller SPT wheals, lower milk-specific and casein-specific IgE
  - Those that reacted had Milk IgE >35kU/L

Baked Milk Impact on Tolerance Development

• 89 subjects categorized by initial baked milk OFC to muffin containing 1.3g baked milk
  - Baked milk reactive (26%) or baked milk tolerant (74%)
  - Baked milk tolerant group sent home on 1-3 servings/day of baked milk
  - Challenged after 6 months to baked cheese and then to un-heated milk
  - Within 60 months, 80% of baked milk tolerant group tolerated un-heated milk
  - Only 2 of the baked milk reactive group developed some tolerance to baked milk

References:

JHU Approach to Baked Milk

Introduction

- OFC to baked milk
- Goal Dose ¼ cup milk baked into cake/muffins
- Those with severe symptoms or moderate symptoms with small amount of baked milk continued to restrict all milk
- Those who tolerated <¼ cup of a baked milk:
  - Generally avoid baked egg
  - In highly select patients may individualize plan
- Those who tolerated ¼ cup baked milk sent home with instructions to add baked milk to their diet

Baked Milk OFC Outcomes

- 114 Baked Milk OFC
  - 9% failed baked milk OFC and continued on milk restriction
  - 18% tolerated <¼ cup baked milk
  - 73% tolerated ¼ cup baked milk
    - 9 subjects failed baked milk introduction and returned to milk avoidance
      Age at time of OFC, severity of prior egg reaction, egg-specific IgE at time of OFC or life-time Max not predictive of outcome

Issues with Baked Milk Introduction

- Too much anxiety, easier to continue restriction
- Chronic GI complaints-back to restriction
- Behavioral issues with milk introduction
- Tolerated baked milk, but reacted to straight milk exposure-now refuses baked milk
- Hives with baked milk exposure-back to restriction
- Throat symptoms with baked milk introduction-back to restriction

Predictors of Baked Egg Tolerance

- 94 subjects with egg allergy
  - +OFC or convincing history with +IgE levels
  - Challenged to small amt of baked egg
    - Sent home and increased "dose" to 1.5g egg protein, daily
    - Challenged 6 months later to baked and then natural egg
  - >90% tolerated baked egg after 6 months of daily baked egg ingestion
    - Only 4 of these subjects subsequently reacted to natural egg OFC
  - Neither skin tests nor egg-specific IgE able to predict tolerance to baked egg

Background on Baked Egg

- Heating egg protein diminishes the allergenicity
- 55% of subjects with positive OFC to freeze-dried egg white tolerated heated egg white
- 73% of subjects with positive egg allergy and positive PST tolerated baked egg
- 43% of subjects with positive egg OFC tolerated heated egg

Predictors of Baked Egg Tolerance

- 52 children with +PST or +egg IgE underwent baked egg OFC
  - 83% tolerated 1/3 baked egg (2.2g of egg protein)
  - None of the 9 subjects with egg PST<10mm failed
  - No positive predictive value for PST (range 0-35mm) or egg-specific IgE (<0.35-13.0)
  - Egg-related clinical history not predictive
    History of: anaphylaxis, severe reaction, other FA, family history, age, co-morbid conditions
Predictors of Baked Egg Tolerance

- 100 baked egg OFCs to 1/3 of a baked egg
  - Clinical history and PST not predictive
  - PST (range 0-19mm) and IgE (range <0.35-75.4kU/L)
  - Egg-specific IgE<2.5 negative predictive value 89%
  - Specificity 44%
  - Egg-specific IgE<10 negative predictive value 71%
  - Specificity 94%

Baked Egg and Development to Natural Egg Tolerance

- Regular ingestion of baked egg appears to accelerates development of tolerance to raw/natural egg

- 79 subjects with documented egg allergy challenged to 1/3 of a baked egg
  - 71% tolerated baked egg
  - 36% went on to develop natural egg tolerance
  - Majority of subjects with persistent baked egg intolerance eventually developed baked egg tolerance and even tolerated natural egg

JHU Approach to Baked Egg Introduction

- OFC to baked egg
- Goal Dose ¼ egg baked into cake/muffins
- Those with severe symptoms or moderate symptoms with small amount of baked egg continued to restrict all egg
- Those who tolerated ¼ of a baked egg:
  - Generally avoid baked egg
  - In highly select patients may individualize plan
- Those who tolerated ¼ baked egg sent home with instructions to add baked egg to their diet

Issues with Baked Egg Introduction

- Angioedema with brownies-refuses baked egg
- Persistent GI symptoms
- Stomach symptoms after a cookie-refuses baked egg
- HATES the flavor-refuses baked egg
- AD flare after Baked egg introduction
- Mouth symptoms and anxiety with baked egg introduction-refuses baked egg

Baked Egg OFC Outcomes

- 115 baked egg OFC
  - 24% failed baked egg OFC and continued egg restriction
  - 23% tolerated ¼ baked egg
  - 52% tolerated ¼ baked egg
  - 5 failed baked egg introduction and went back to egg avoidance

- Age at time of OFC, severity of prior egg reaction, egg-specific IgE at time of OFC or life-time Max not predictive of outcome

Common Problems Seen During Baked Milk and Baked Egg OFC

- Oral puritis, especially on first bite
- Increased anxiety as it is often a food child has reacted to in past
- Unable to complete the goal dose because it is too much food to eat
- Parents bring in a variety of baked goods that make dosing calculations become "fun math"
- Child is not use to eating a baked good and refuses to eat it due to texture
Recipe for Baked Milk OFC

- Use any commercial cake/muffin mix
- Can use gluten-free cake/muffin that calls for 1 cup milk
- Replace water with 1 cup milk PLUS 1/3 cup dried milk powder
  - 1/3 cup Instant dry milk powder = 1 cup milk
  - Helpful hint: Combine the powdered milk into the cup of wet milk before adding to the mix
- Does not matter if milk is skim, 1%, 2% or whole milk
- Use egg substitute of the child is egg allergic

Recipe for Baked Egg OFC

- Use any commercial cake/muffin mix
- Can use gluten-free cake/muffin that calls for 2-3 eggs
- Size of egg is not a huge issue
- Use a water or milk substitute if the recipe calls for milk and your child is milk allergic

Jaffe Food Institute Baked Egg Recipe

- 1 cup flour
- ¾ teaspoon salt
- 2 tablespoons milk (cow, rice, almond, soy)
- 1 teaspoon Baking Powder
- ¾ teaspoon cinnamon
- 2 eggs
- ¾ cup sugar
- ¼ cup oil
- 1/2 teaspoon vanilla
- 1 cup ripe mashed bananas or applesauce

Oven to 350 degrees. Mix wet ingredients in 1 bowl and dry in another. Add wet to dry. Divide batter into 6 lined muffin cups. Bakes 30-35 minutes

Yield 6 muffins (1/3 egg per muffin)

Sample Calculations for Baked Milk

24 cupcakes or muffins made with 2 cups milk (1 cup wet milk plus 1/3 of a cup of dried milk powder)

- If the goal dose is 1 cup of baked milk
  - Then you must eat 12 cupcakes
- If the goal dose is ½ of a cup of milk
  - Then you must eat 6 cupcakes
- If the goal dose is ¼ of a cup of milk
  - Then you must eat 3 cupcakes
- If the goal dose is 1/8 of a cup of milk
  - Then you must eat 1½ cupcakes
- If the goal dose is 1/16 of a cup of milk
  - Then you must eat % of a cupcake

Sample Calculations for Baked Egg

24 cupcakes or muffins made with 2 eggs

- If the goal dose is 1 egg
  - Then you must eat 12 cupcakes
- If the goal dose is ½ egg
  - Then you must eat 6 cupcakes
- If the goal dose is ¼ egg
  - Then you must eat 3 cupcakes
- If the goal dose is 1/8 egg
  - Then you must eat 1½ cupcakes
- If the goal dose is 1/16 egg
  - Then you must eat % of a cupcake

Baked Milk Instructions

- OK to add processed foods with milk as a minor ingredient
  - Milk listed in the bottom third of the ingredient list
- OK to add foods with milk Precautionary labeling
- Avoid foods with cheesy residue
- You may bake with butter, cream cheese, sour cream or yogurt
- Your child can eat the baked milk every day, he/she does not have to eat it every day
Baked Egg Instructions

• OK to add processed foods with egg as a minor ingredient
• OK to add foods with egg Precautionary labeling
• Your child can eat the baked egg every day, he/she does not have to eat it every day
• Avoid baked goods that do not bake thoroughly in the middle, such as brownies or moist cookies, casseroles, or pies

Common Problems Encountered with Home Introduction

• If there is a problem it is almost always with baked egg
• If a problem is going to occur it is usually in the beginning of introduction
• Need to make sure food is well baked
• Be careful with store bought foods
• Continued anxiety and reluctance of the child to eat the baked goods at home
• Understanding the math calculations

Future Directions

• A diet that included baked milk or baked egg induces the same immunologic changes that we see with milk/egg immunotherapy
• Tolerance of baked milk is a marker of mild milk-allergy phenotype
• 60% of baked-milk tolerant patients will become tolerant to straight milk over time
• Ingestion of cooked egg is well tolerated and may hasten tolerance development
• Cofar studies comparing baked egg and egg powder in inducing egg tolerance