

# Neonatal Rat Gastrostomy

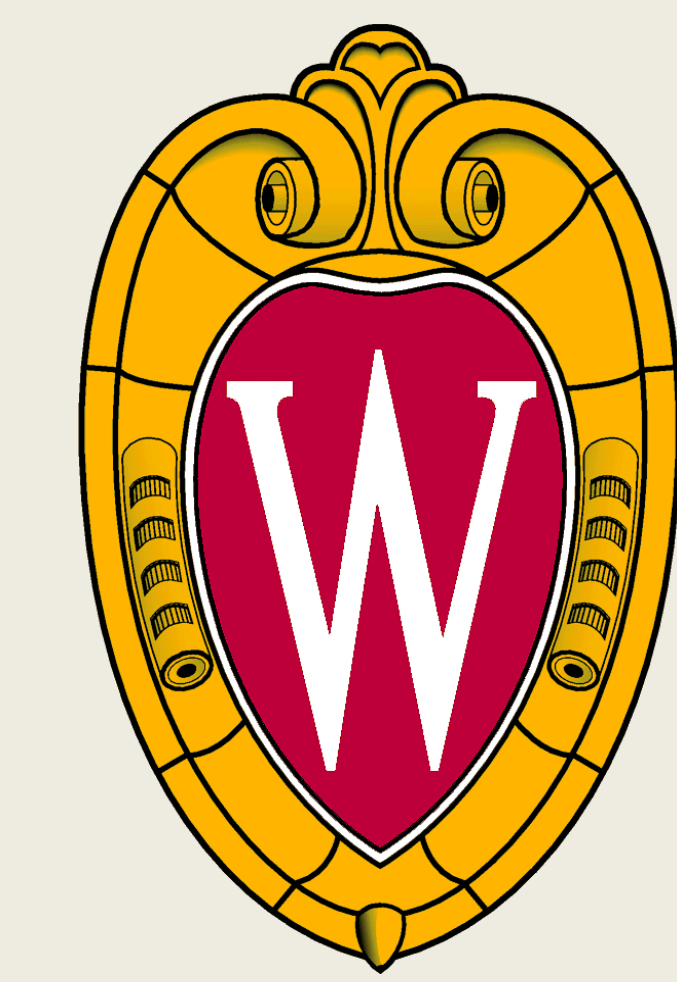
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## Motivation



- 30,000 premature babies are effected by anemia annually<sup>[3]</sup>
- Common treatment of hormone erythropoietin for anemia in adults is not sufficient for babies
- Premature babies are iron and erythropoietin deficient
- Our client is studying the affects of iron deficiency on neonatal rats to mimic the study of humans<sup>[3]</sup>
- Gastrostomy is used to feed rats iron deficient milk

Fig. 1-Rat pup being tested after successful gastrostomy procedure—current survival rate of the rats is less than 50%

## Background

### Current Procedure

#### Make Phalange Tip

- Use Polyethylene Tubing (PE-20)
- Prepare tube days before surgery
- Cut 3 Phalanges with surgical scissors
- Mold by alternating 80°C water and ice water

#### Surgery Procedure

1. Anesthetize rat pup
2. Insert needle with external sheath
3. Remove needle, leaving sheath in stomach
4. Insert tubing via separate insertion catheter
5. Remove sheath and insertion catheter
6. Secure tube with washer to abdominal wall
7. Wrap tube around rat and clamp in back of neck
8. Weigh rat pup and place in simulated environment



Fig. 2-Surgery procedure step 4

Fig. 3-Surgery procedure step 5

Fig. 4-Surgery procedure step 7

### Problems with Current Procedure

#### Survival Rate

- Less than 50% survival rate
- Most rats last only 2-3 days

#### Hole Size

- Sheath around needle is .56mm larger than tube (50% larger)
- Milk leaks into abdominal cavity

#### Tubing and Phalange tip

- Phalanges fail - pull out or tear stomach
- Phalanges are inconsistent and difficult to make
- Excessive constant tension on tube after initial securement

## Problem Statement

The purpose of this project is to increase the survival rate of rat pups being tested for the effect of iron deficiency on their physiological development. Our task is to adapt the current gastrostomy procedure by designing a mechanism and/or technique to secure a feeding tube inserted through the abdominal wall into the rat's stomach.

**Client Specifications:** Tube needs to be secured in stomach for 8-10 days during testing, allowing milk to be pumped through the tube 20 minutes per hour. It needs to have a simple, repeatable fabrication, a noninvasive procedure technique, and an improved survival rate of 80%.

## Final Design

### Tip Structure

- Double phalange
- 3 curlicues

### Fabrication

- Use 15 cm long PE tubing
- Cut double phalange using razorblade
- Insert small copper wire 4-5 cm deep in tip
- Grip tip just below phalanges with tweezers
- Wrap around 3 times and secure in pipette tip
- Mold by alternating 100°C water and ice water

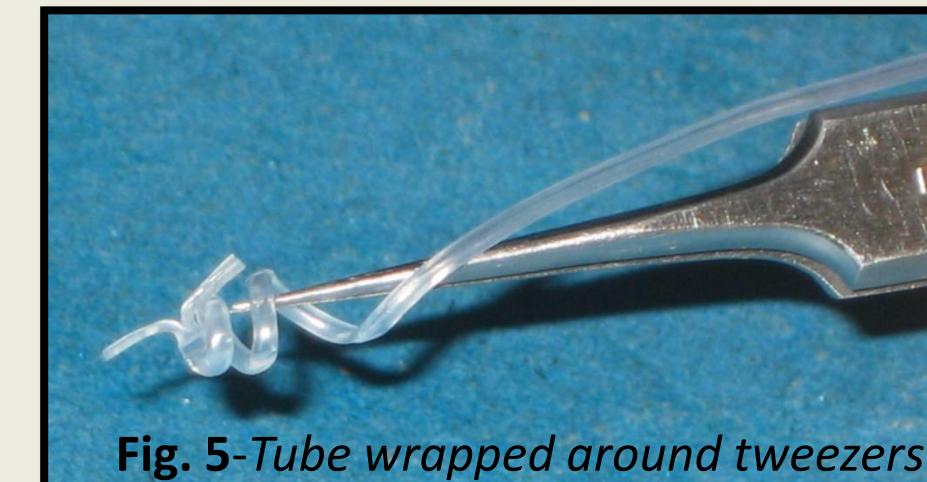


Fig. 5-Tube wrapped around tweezers

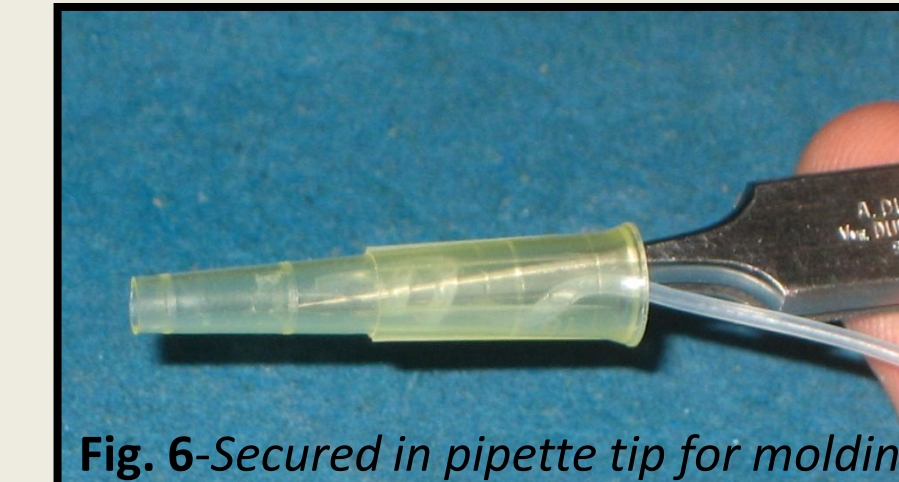


Fig. 6-Secured in pipette tip for molding

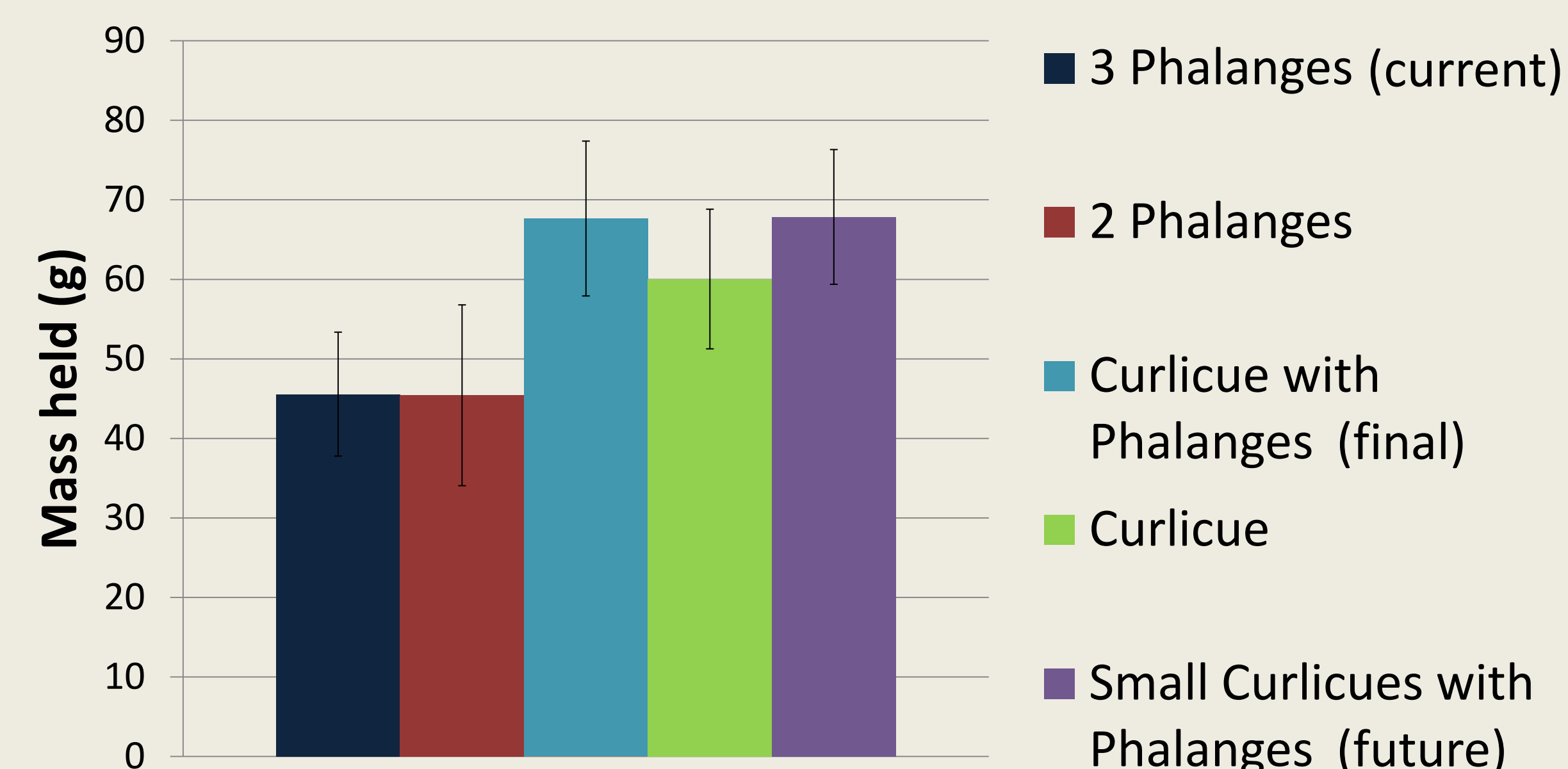


Fig. 7-Final curlicue with phalange design

## Testing

### Mechanical Testing

#### Strength of Tubing Tips



### In vivo Testing

#### Surgery

- Client performed gastrostomy surgery on 16 neonatal rats
- 4 rats were inserted with final recommended design

#### Results

- 3/4 rats with final design died within first 2 days
  - Tip held tubing in stomach securely
  - Rats died because curlicues were too large in stomach
- 8/12 rats with original 3 phalanges survived testing period
  - Demonstrates that survivability depends more on procedure

### Testing Procedure

- Held tube in plastic sheet
- Hung weights from tube
- Increased amount of weights held until tip failure

### Results

- Final design holds statistically more weight than 3 phalanges ( $p = 0.051$ )
- 2 phalanges show no significant difference than 3 phalanges



Fig. 8-Rat pup in simulated environment for in vivo testing

## Discussion

**Mechanical Testing** shows that curlicue with double phalange is significantly stronger than the currently used 3 phalanges

**In vivo Testing** failed during initial *in vivo* studies due to size of the curls and the initial insertion of the tip

- Large curls prevented the stomach from emptying , causing the stomach to swell
- Curl was not inserted completely in stomach, causing stomach to twist around itself

## Limitations

- Not able to change procedure significantly, due to prior research done with current procedure
- Must use same needle size
- Design focused primarily on securement of tip in stomach rather than to facilitate surgical procedure

## Future Work

### Tighter curlicue

- Testing showed that 2 tight curls did not lose any mechanical strength compared to the 3 looser curls
- Needs to be tested on rat pups
- Improve insertion method so assistance is not needed

### Procedure enhancement

- Look into imaging technique such as ultrasound so it is easier to locate stomach
- Explore method of insertion through the mouth for future research
- Make a phalange cutting tool

## References

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