

CALIBRATED EYE DROPPER

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Abstract

Glaucoma is a disease of the eye that can cause loss of vision and may lead to blindness. Researchers at the University of Wisconsin-Madison use animal test subjects for glaucoma medication testing. Eye drops are delivered to the eyes of the animals via a micropipette. This method endangers the animal. The researchers need a new eye dropping mechanism which minimizes time between drop deliveries, is accurate and precise, and does not pose danger to the animals in case of contact with the eye. A miniaturized pipette has been fabricated which incorporates the commercially available MiniFIX into an ergonomic grip with a tip ejector. An Eppendorf holder accompanies this device. Testing has shown that the fabricated grips appeal to the users and the design delivers $4.6 \pm 0.2 \mu\text{L}$.

Motivation

- Department of Ophthalmology and Visual Sciences
- Glaucoma therapy testing in animals
- Test ability of different drugs to lower intraocular pressure [1]
- Device must accurately and efficiently deliver 5 μL drops
- Client currently uses standard micropipettes
 - Delivers exactly 5 μL drops
 - Is time consuming
 - Endangers animals
 - Makes drop placement difficult
- Shorter device length will enhance animal safety
- The objective is to optimize accuracy, efficiency, and animal safety in optical drug delivery

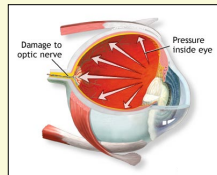


Figure 1. Glaucoma creates fluid pressure inside the eye that can cause damage to the optic nerve [2].

Current Devices



Figure 2. Microzipette Hand Held Dispenser [3].

- Standard micropipette
- Microzipette Hand Held Dispenser cannot be scaled to micro liters
- Eppendorf Repeater Plus Pipettor is too long for client's application
- US patents (6610036, 7073733, and 5881956) utilize mini ophthalmic pumps which are too bulky



Figure 3. Eppendorf Repeater Plus Pipettor [4].

Design Criteria

- Functionality of a typical eye dropper
- Accuracy of a calibrated 5 μL micropipette
- Small size with grip approximately 3.5 inches tall
- Weigh between 50-100 grams
- Wide range of viscosities
- Capable of performing 2000 times per month
- \$200 or less

Final Design

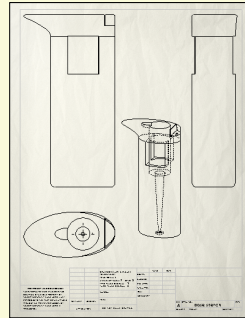


Figure 4. Sketch of prototype design highlighting modifications to standard pipette grip.

Eppendorf Holder

- Dental hygienist ring
- Three holes drilled in circular dish that fit 0.5mL Eppendorfs

Cost Analysis

- Total per prototype: \$104.05
- Pipette Grip - \$50.00 (donated)
 - Tip Ejector - \$28.00 (donated)
 - MiniFIX 5 μL Micropipette - \$19.80
 - PMMA - \$3.75/oz (donated)
 - Hygienist Rings - \$2.50 each (donated)

Mini Micropipette

- Standard micropipette grip with internal components removed
- Standard grip improves ergonomics
- Removable MiniFIX 5 μL pipette
- PMMA mold stabilizes MiniFIX in grip
- Tip ejector modified for shorter pipette

	Purple Pipette Grip	Blue Pipette Grip
Length (cm)	14.9	14.9
Weight (g)	46.93	49.80

Table 1. Dimensions for both the purple and blue grips



Figure 5. Eppendorf holder fabricated for holding three Eppendorfs.

Testing

Pipette Accuracy

- Drops of distilled water weighed on analytical balance
- 5 μL weighs 5 μg
- Prototype should dispense 5 μL
- Average volume was $4.6 \pm 0.2 \mu\text{L}$
- Average error was 8.78%

Pipette User Survey

- 10 individuals ranked four pipettes from best to worst with 4 being the best
- Users considered pipette comfort, animal safety, and controllability

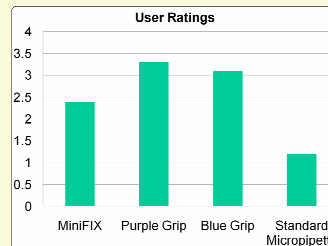


Table 2. Table of user ratings. Average scores from 10 users.

Future Work

- Contents of Eppendorfs may spill from ring
 - Products to consider: Piercable Septa Cap - 8 mm polyethylene plug caps with starburst tops (\$50.78/1000 units)
 - Cepure Zero Injection Port Septa, Red Silicone (\$41.15/10 units)
- MiniFIX pipettes have higher percent error than rated
 - Solution: Find or develop a small pipette with better accuracy
- Speed has increased, but could be improved upon
 - Solution: Create a miniaturized electronic repeat dispenser pipette
- Size not to client's optimum desire
 - Solution: Minimize pipette mechanisms to size of a 15 mL eye dropper bottle
 - Design a valve specific to dropper bottle that will allow dropper bottle to dispense 5 μL



Figure 6. Cepure Zero Injection Port Septa, Red Silicone [6].

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