Non-metallic Intraocular Foreign Body Extraction Device

Carly Hildebrandt, Amy Kim, Ruby Phung, Adam Strebel
Client: Dr. Leslie A. Wei, Ophthalmology Facial Plastic Surgery
Advisor: Pr. John Webster, Department of Biomedical Engineering

Abstract

Intraocular foreign bodies (IOFB) account for nearly 40% of open-globe ocular traumas. When they penetrate the eye, they are subject to surgical removal. However, removal is complicated when the IOFB are round, smooth, and non-metallic, such as air soft pellets. Currently, no surgical instrument exists specifically to remove these IOFB. An instrument, with a locking grasp mechanism was designed to remove air-soft pellets six millimeters in diameter. A retractable claw prototype device was fabricated and tested for user comfort and reliability.

Background

Intraocular Foreign Bodies (IOFB)

- Penetrate ocular tissue
- Retained inside eye
- Range in size and composition variably
- Subject to surgical removal [1]

Human Eye Anatomy

- IOFB penetrates:
  - Cornea (65%)
  - Sclera (25%)
- IOFB retained by:
  - Vitreous Body (61%)
    - Gel-like fluid
    - Pressurizes eye
  - Anterior Chamber (15%)
  - Retina (14%)
    - Optic nerves
    - Delicate [3]

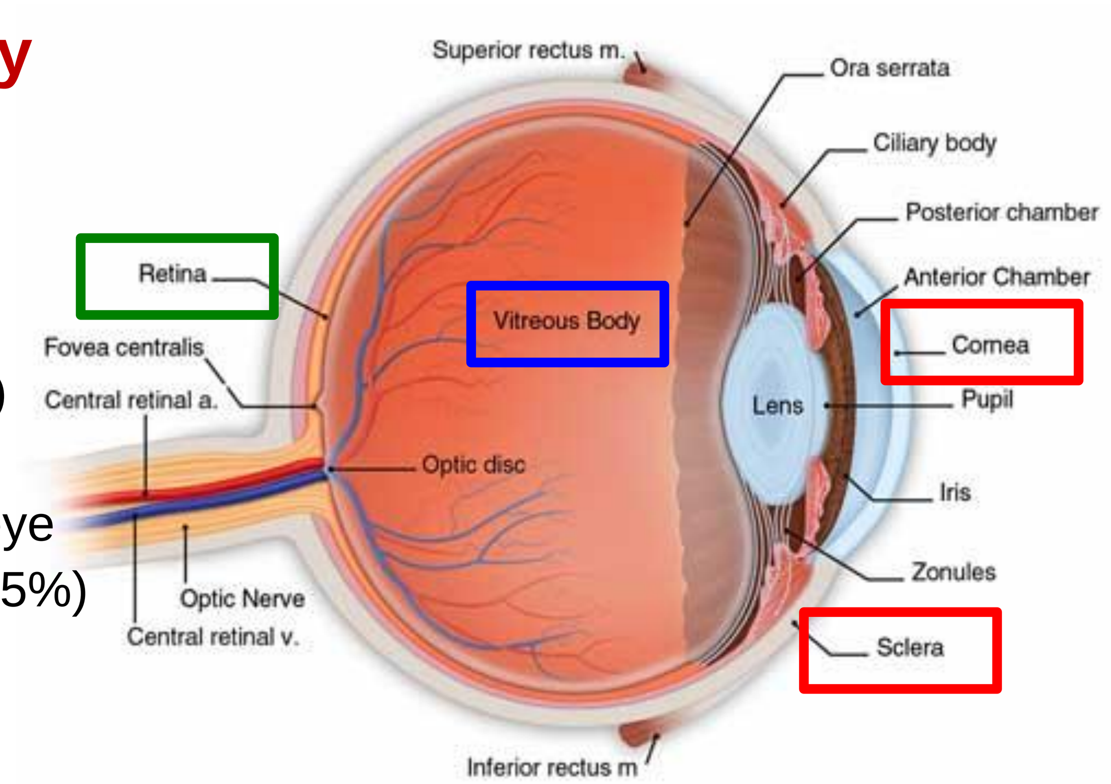
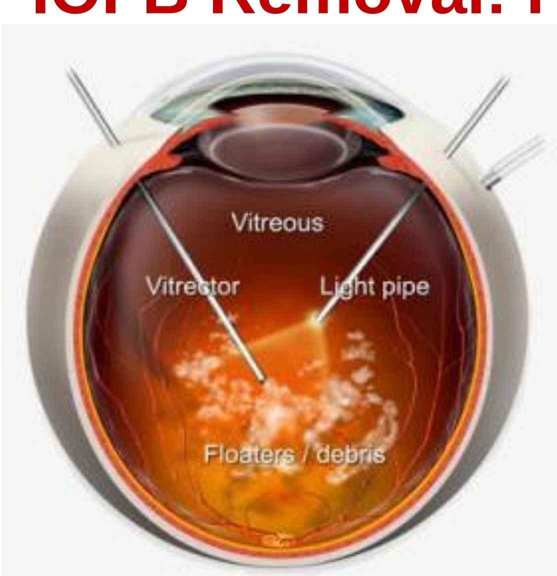


Figure 1: Anatomy of Human Eye.[2]

IOFB Removal: Pars Plana Vitrectomy



- Remove vitreous
  - Vitrector
- Retrieve IOFB
  - Forceps
  - Magnet
- Extract IOFB from sclera

Figure 2: Pars Plana Vitrectomy.[4]

Figure 3: IOFB Removal.[5]

Design Requirements

- Disposable or autoclavable
- Biocompatible
- Minimal entrance wound
- Comfortable no-slip grip
- Intuitive one-handed operation
- Locking grasp around IOFB

Final Design

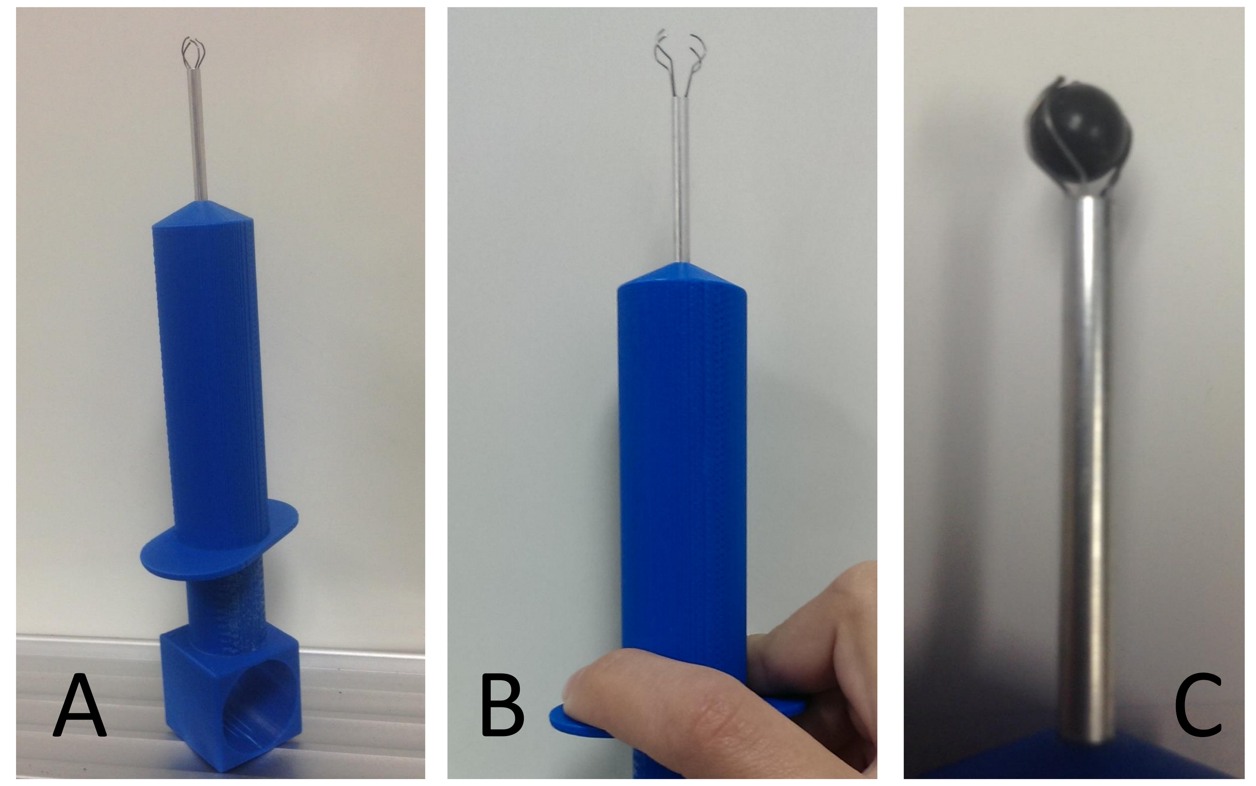


Figure 4:
(A)Final prototype with claw retracted (closed)
(B) final prototype with claw released (open)
(C) claw grasping airsoft pellet

Features:

- Four-pronged claw to grasp IOFB
- Claw retracted into middle rod until released
- Syringe-design handle compresses to release and open claw
- Finger loop for comfort and safe retraction

Prototype Fabrication

Handle

- 3-D printed using acrylonitrile butadiene styrene
- Main body inspired by syringe
- Spring fitted inside main body, spring stiffness constant ~ 500 N/m
- Plunger placed inside main body to compress spring and release claw

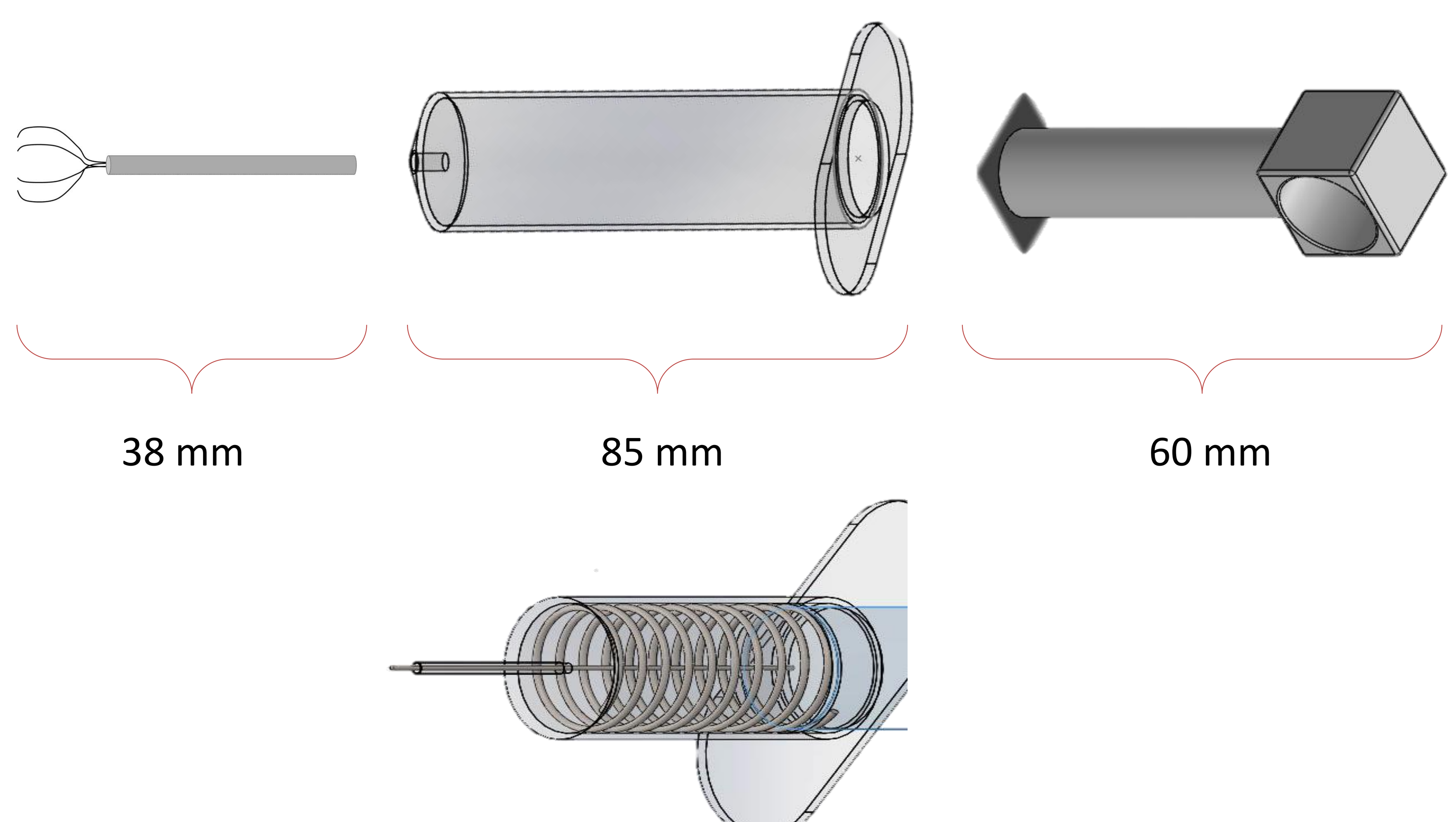


Figure 5: SolidWorks Design of Final Prototype.

Testing & Analysis

Testing

Performance Testing

- Task: Pick up an airsoft pallet from the water with vitreous fluid
- Current device (forceps) vs. our design (Claw)
- Ten trials measuring for:
  1. Required time for successful removal
  2. Number of retries required until successful removal
- Averaged values and standard deviation

Results and Analysis

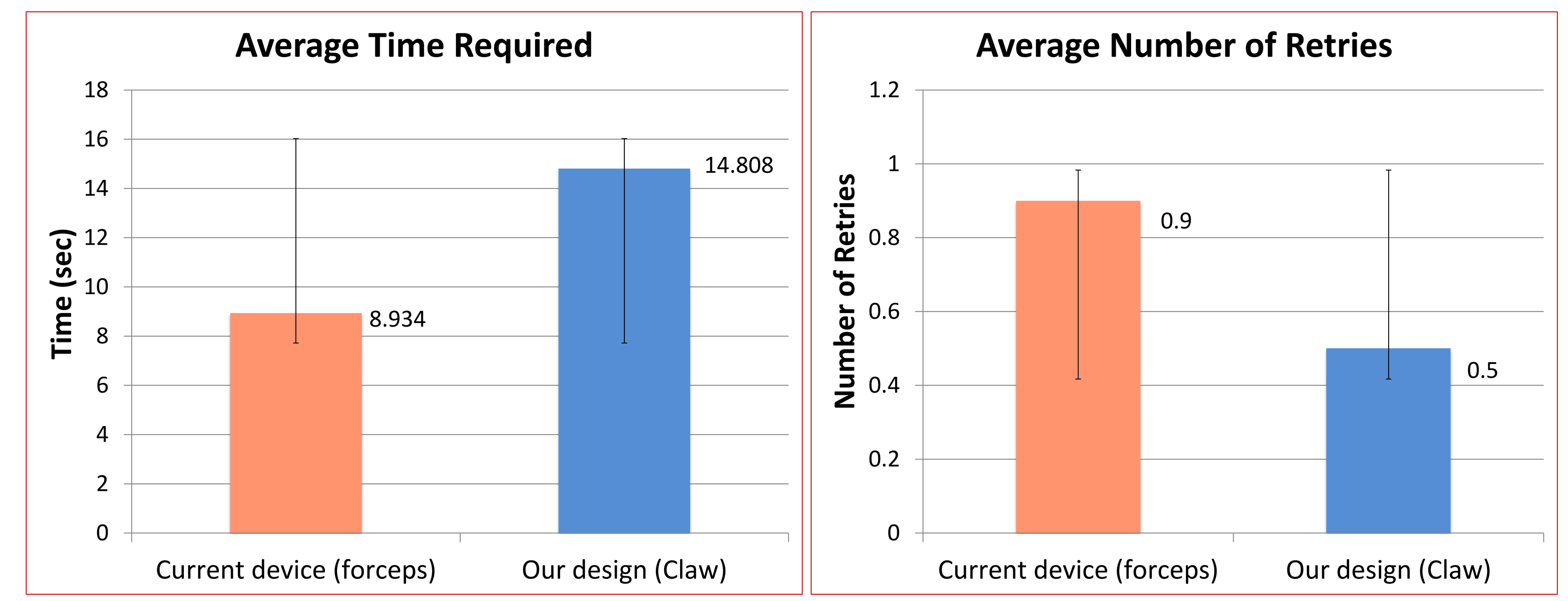


Figure 6: Comparison of Average Time Required for Removal (left) and Number of Retries (right) between Prototype (blue) and Current Device (red).

Future Work

Current Design and Testing Alterations

- Scale reduction
- Choice of materials
- Professional industrial fabrication
- Refine the prong's design for better performance
- Additional stop-lock mechanism to ensure the protrusion length
- A smooth release mechanism
- More testing on animals

Acknowledgements & References

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