DEVICE FOR EXTRACTION OF NON-METALLIC INTRAOCULAR FOREIGN BODIES

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Client

- Dr. Leslie A. Wei, MD
- Ophthalmology Facial Plastic Surgery
- UW-Madison Hospital
Problem Statement

- *Traumatic intraocular foreign bodies (IOFB)*
  - Smooth, round, non-metallic foreign bodies are difficult to remove
    - Ex. Airsoft pallets

- Currently no specific instrument

- **Goal**: design an intraocular instrument
  - 1. Minimizes enlarging the wound
  - 2. Easily handled with precise movements
  - 3. Successful in removing the IOFB

Retrieved from bbgunreview.com
Background: Human Eye

- IOFB enter through:
  - cornea (65%)
  - sclera (25%)
  - Etc.

- IOFB end up in:
  - Vitreous body (61%)
  - Anterior chamber (15%)
  - Retina (14%)
  - Etc.¹

- Vitreous body
  - Gel-like vitreous fluid
  - Pressurizes eye²

- Retina
  - Optic nerves
  - Sensitive

Figure 1. Anatomy of a human eye³
Background: IOFBs

- **IOFB** = *intraocular foreign bodies*
  - Penetrate into ocular tissue\(^4\)

- Common types - causes:
  - Metal - hammering
  - Plastic - BB guns

- Commonly injured sites
  - Lens and retina\(^5\)

Figure 2. Hammer & Nail\(^6\)
Figure 3. BB gun and plastic BB bullets\(^7\)
Background: IOFB

- Our target:
  - Round, plastic
  - Maximum diameter 8 mm
  - In posterior segment (vitreous body)

Figure 3. Anatomy of removing IOFB⁸

Figure 4. Image of samples of air soft pallets of 6 mm diameter⁹
Procedure: Pars Plana Vitrectomy

**Steps**

1. Remove vitreous (vitreector)
2. Sever IOFB-vitreous attachment (vitreector)
3. Insert instrument for grasping
4. Grasp IOFB
5. Move IOFB to sclera
6. Extract IOFB

Figure 5. 25 gage-Vitrector designed by Alcon Surgical

Figure 6. Diagram of Pars Plana Vitrectomy: An animated cross-section of the eye including the components used during a vitrectomy procedure
Current devices\textsuperscript{13}

- Currently, no instrument designed specific for removing smooth, round, and non-metallic IOFB

- Commonly used: 25+gage Forceps
  - Various kinds of tips
  - Difficult if non-metallic IOFBs

Figure 7. Examples of currently used forceps with various kinds of tips for IOFB removal. Designed by Alcon Surgical
Product Design Specification

• Size
  • Maximum diameter: 8 mm
  • Length: 32 mm

• Safety
  • Biocompatible
  • Disposable or autoclavable
  • Not harmful to inner-eye
  • Minimize entrance wound

• Ergonomics
  • One-handed operation
  • Comfortable no-slip grip

• Reliability
  • Locking mechanism
Design #1: Ice cream scoop

- Two half-spheres encapsulate foreign body
- Spring and gear mechanism rotates half-sphere
- Autoclavable
  - stainless steel

![Figure 8. Model of an ice cream scoop](image-url)
Design #2: Fish net

- Spring embedded in handle

- Mechanism:
  - Push
    - Compresses the spring
    - Pushes out the net
  - Release
    - Relaxes the spring
    - Pulls in the net

- Disposable
  - Polymer

Figure 10. Image showing the mechanism of Fish Net design

Figure 11. Currently in use Roth Net Retriever for grabbing objects in digestive tract
Design #3: Claw

- Four prongs to grasp foreign body
- Spring-loaded mechanism to release claw
- Relaxing spring tightens claw
- Autoclavable
  - Stainless steel

Figure 11. Example of a claw design currently in use\textsuperscript{16}
# Design Matrix

<table>
<thead>
<tr>
<th>Criteria (weight)</th>
<th>Ice Cream Scoop</th>
<th>Fish-net</th>
<th>Claw</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliability (30)</td>
<td>5 30</td>
<td>4 24</td>
<td>3 18</td>
</tr>
<tr>
<td>Size (25)</td>
<td>4 20</td>
<td>5 25</td>
<td>3 15</td>
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<tr>
<td>Ergonomics (15)</td>
<td>5 15</td>
<td>4 12</td>
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<tr>
<td>Safety (15)</td>
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<td>5 15</td>
<td>3 9</td>
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<tr>
<td>Feasibility (10)</td>
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<td>5 10</td>
<td>4 8</td>
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<tr>
<td>Cost Effective (5)</td>
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<td>3 3</td>
<td>5 5</td>
</tr>
<tr>
<td>Total (100)</td>
<td>84</td>
<td>89</td>
<td>64</td>
</tr>
</tbody>
</table>
Summary: Final Design

- Design #2. Fish net
  - Highest relative score
  - Size
  - Safety
  - Feasibility
Future Work

• Material Selection

• Order materials and components needed

• Fabricate a prototype

• Testing
  • Model: cow/pig’s eye
  • Ease of use and controls
  • Successfully removes
  • Does not enlarge the wound
Acknowledgement

- Client: Dr. Leslie Wei
- Advisor: Dr. John Webster
References


Questions?