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# Anterior segment laboratory: Foreign body removal apparatus construction

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## Abstract

INTRODUCTION All optometric physicians must be skilled in foreign body removal from the human eye. To this end, an apparatus for effectively practicing various techniques is proposed, with the pig eye as the preferred model.

METHODS Assembly and application of a prototype for a pig eye holder is illustrated. Third year optometric students evaluated the device and questionnaires were completed to determine the value in practice.

RESULTS Overall, the eye model was a successful practicing tool for the removal of ocular foreign bodies. Minor adjustments to the appearance and presentation are needed to improve the likeness of the replica to that of a human eye.

CONCLUSIONS The proposed apparatus is an excellent teaching device. Ease of construction, reusability, and low cost make it invaluable. Simple modifications could improve the experience for students, and further testing using the model may provide beneficial information.



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Master of Science in Vision Science

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Elizabeth Davis

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## Subject Categories

Optometry

# ANTERIOR SEGMENT LABORATORY:

# FOREIGN BODY REMOVAL APPARATUS CONSTRUCTION

By

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MARY MILLER
MIKAYLA UPHOFF

*Thesis statement:*
*There is a recognized need for improved teaching models, and the use of pig eyes for the practice of ocular foreign body removal serves that need.*
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Advisors:

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**SIGNATURE PAGE**

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**GRADE PAGE**

ANTERIOR SEGMENT LABORATORY:
FOREIGN BODY REMOVAL APPARATUS CONSTRUCTION

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## BIOGRAPHY PAGE

Cori Cooper attended Truckee Meadows Community College and the University of Nevada – Reno, where she completed much of her undergraduate coursework. She was awarded a Bachelor of Vision Science degree from Pacific University in Oregon while pursuing a doctorate degree at the Pacific University College of Optometry. During her time at the college, she was a member of Amigos Eye Care and the Sports Vision Club, served as a student representative on the University Board of Appeals Committee for two years and worked as a teacher's aide for the Ocular Disease Laboratory courses for one year. Cori will provide eye care to the Reno/Sparks community in Northern Nevada following her graduation in 2006.

Mary Miller attended South Dakota State University in Brookings, South Dakota, where she completed her Bachelor of Science degree in Microbiology and Biology. While at Pacific University College of Optometry, she contributed to Amigos Eye Care, NOSA, and the Sports Vision Club. She also served as a teacher's assistant in the Posterior Segment Disease Laboratory courses. Mary will provide eye care in the South Dakota and Minnesota areas following her graduation in 2007.

Mikayla Uphoff attended Kansas State University in Manhattan, Kansas, where she completed her Bachelor of Science degree in Biology. While at Pacific University College of Optometry, she was the Armed Forces Optometric Society Local Liaison and a student member of the Kansas Optometric Association. She has also been involved in NOSA, AOA-PAC, AOSA, and SOA. After graduating in 2007, Mikayla will serve as an optometrist for the United States Navy.

## ABSTRACT

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KEY WORDS/PHRASES
Foreign Body, Bovine, Porcine, Pig Eye, Cow Eye, Human Eye, Optometrist, Eye Care Professional

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Thank you, also, to the students who donated time and effort to this project. It is for their future colleagues and the betterment of the profession that this study was prepared.

## INTRODUCTION

In the United States, the most frequent cause of ocular emergency visits is the foreign body. Like the several other injuries that are traumatic in nature, the peak incidence of the foreign body is in males in their second decade (1) Ocular foreign bodies are most frequently found in anterior segment structures with notable predilection for the cornea (2).

Optometric physicians are expected to possess the skills necessary to perform corneal foreign body removal (as described within their states scope of practice). In most cases, the required procedure is straightforward if the physician is proficient (3). Prompt and efficient management of an ocular foreign body can be the difference between preserved sight and irreversible vision loss, and there is no predicting when such a case might present to the physician's office (4).

There are various methods and tools utilized by eye care professionals to remove offending projectiles and substances from ocular tissue. As with many clinical procedures, it is imperative that students of optometry have an opportunity to perform corneal foreign body removal prior to clinical practice.

In the opinion of the researchers, the most realistic specimen available for such practice is the porcine eye. Porcine organs have been widely used as models for human procedures in medicine because of the likeness to human organs (5). In addition to the parallel between human and porcine ocular anatomy, the texture and size of the porcine eyes are more conducive to practicing procedures than the bovine model currently utilized. To date, Pacific University has used bovine eyes for the teaching of foreign body removal. These eyes are much larger than human eyes and have often been frozen, resulting in corneal compromise. Using fresh porcine eyes, which are readily available, offers a more realistic alternative. A device that will hold the specimen should be easy to construct, reusable, cost effective, and easy to clean.

## METHODS

A prototype was built using materials that can be easily obtained at a beauty supply store and plumbing hardware store.

### Materials

- One 1 inch (internal diameter) PVC union set – one end smooth, one end threaded (Fig. 1)
- One piece of gray plumbing tube: Fernco® PlumbQwik – 0.50 inch internal diameter on the smaller end, 0.75 inch internal diameter on the other end (Fig. 3 D)
- One Styrofoam head
- Scissors
- Drill press

**Fig. 1.** Pieces of the eye model vessel: PVC union set and plumbing tubing.

## Construction

### Preparation of the Styrofoam Head

The Styrofoam head that holds the teaching device was prepared by cutting a hole approximately 8 cm x 8 cm x 9cm (height X width X depth). This allowed the PVC union to securely fit into the Styrofoam holder.

### Preparation of the Plumbing Tubing

Four separate half inch slits were cut into the larger 0.75 inch end of the gray plumbing tubing to allow for expansion and easier insertion of the porcine specimen.

## Preparation of the PVC Unit

Using a drill press, the back lip of the threaded PVC union set was carefully sanded down to allow the gray tubing to fit snugly.

**Fig. 2.** Slits are cut into the larger diameter end (0.75 inch) of the plumbing tube for easier insertion of the porcine eye

## Assembly of Final Vessel

The smaller 0.50 inch side of the tubing was inserted first, leaving the larger 0.75 inch end exposed, and thus the slits exposed. The threaded side (Fig. 3 C) was then attached to the smooth end (Fig. 3 B placed into 3A) of the union set (As seen in Fig.4 and Fig. 5) and the apparatus was inserted into the Styrofoam head (Fig. 6). Once constructed, the depth of the apparatus within the Styrofoam head could be easily manipulated to work with a variety of slit lamps. The Styrofoam heads themselves can be altered to allow practice of both left and right eyes. As constructed, the researchers hoped the apparatus would allow control of globe pressure, thus contributing to the realism of the procedure.


**Fig. 3.** Ready for assembly

**Fig. 4.** Midway through

**Fig. 5.** Complete

## Specimen Preparation

With our resources, slaughtering of cows is done once or twice a week whereas pigs are slaughtered on a daily basis. Obtaining porcine eyes allowed for the most realistic, freshest specimens possible. Once the specimens were obtained, the periorbital fat was excised for cleaner entry into the gray plumbing tube.

**Testing**

Thirty-three third year students at Pacific University College of Optometry volunteered to test the device. Each of these students had previous training in foreign body removal using a bovine eye model and was deemed proficient in their skills. The previous model, using bovine specimens was much larger and more cumbersome to construct than this model. The bovine globes required more preparation time due to the removal of much more periorbital fat and muscle tissue. Additionally, the eyes were often several days old and in some cases frozen before students received hands on training for the procedure. Using the porcine model the researchers constructed, the students simulated the removal of a superficial corneal foreign body using a cotton tip applicator (Fig. 7.). Immediately after testing the device, each student completed a questionnaire evaluating several different aspects of the new model.

**Fig. 6**. Vessel and head are secure in slit lamp

**Fig. 7.** Device utilization

## RESULTS

The questionnaire (page 6) completed by the students rated the convenience of set up/ disassembly/ cleaning of the apparatus, use of the model with slit lamp, reproducibility, similarity of porcine eye to human eye, globe pressure, comparison of porcine eye to bovine eye, overall design and overall efficiency.

The apparatus rated above median (2.5) in all areas questioned, with the highest score of 4.7 given to the ease of slit lamp focus on the ocular structures. The similarity of porcine eyes to human eyes received the lowest rating of 3.5, with intraocular pressure following close behind with a rating of 3.7. Overall, the average score was 4.29 (Table I). In general, the researchers agreed with the outcome of the survey.

## DISCUSSION

While the apparatus scored well overall, the lowest rating was given to the similarity of the porcine eye to a human eye. This may be due to the absence of lids and lashes, which in turn means no blink reflex. This lack of animated response could translate as a lack of resemblance to a live subject. Considering the students only prior exposure was to the bovine eye, it was interesting to the researchers that this aspect was ranked lowest. The investigators noted that corneal clarity and epithelial integrity at the time of testing was markedly improved with the use of the porcine eye. This can be directly attributed to the ability to obtain and evaluate the porcine eyes on the day of slaughter.

For subsequent reconstructions, it is important to take into consideration the size of the specimen. Just as human eyes vary in size, so too do porcine eyes. Keeping smaller eyes in place presented a challenge, because they tended to slide backward into the tube. As a result it was difficult to maintain ideal globe pressure to perform the procedure. The difference in apparent intraocular pressure between the model porcine eye and that of a live human eye may also have contributed to the perceived lack of similarity. In future devices, ocular pressure may be better maintained by reducing the number and depth of slits or adding a clamp. Devising a way to load the eye from the back might also result in overall increased resistance within the system. Additionally, suggestions from the students included that the construction of the model be modified so that the tubing is flush with the Styrofoam head. Additions could also be made to the appearance of the model, such as adding "lids" and "lashes" to simulate the human presentation.

Future contributions to this study might include trials evaluating the model using a wider range of foreign body materials (metallic, vegetative, wood, etc). The applicable tools (i.e. Alger Brush, "spud", etc) could then be used to practice the removal of these more deeply imbedded corneal foreign bodies. Adaptations to this device may make it a viable tool with which to teach and practice injections, stromal puncture, Yag capsulotomy, and paracentesis.

## CONCLUSION

Based on survey results, the use of a porcine eye model for the teaching and practicing of foreign body removal proved to be an excellent teaching tool. It is readily available, easy to construct and reusable, and is highly cost effective.

## Is this an efficient set-up for foreign body removal?

Thesis group: Mary Miller, Mikayla Uphoff, Cori Cooper

1. **How convenient is the set-up/construction?**
   Bad — Neutral — Good
   1 - - - - 2 - - - - 3 - - - - 4 - - - - 5

2. **Did the set-up/construction affect the use of the slit lamp? Was it easy to focus and view the structures?**
   Very hard to use — Neutral — Easy to use
   1 - - - - 2 - - - - 3 - - - - 4 - - - - 5

3. **How convenient is the disassembly of the device?**
   Difficult/Hard — Neutral — Easy/No problem
   1 - - - - 2 - - - - 3 - - - - 4 - - - - 5

4. **Is the set-up easy to clean and therefore reusable?**
   No way — Neutral — Definitely
   1 - - - - 2 - - - - 3 - - - - 4 - - - - 5

5. **Would this device be easy to reproduce?**
   Difficult to do this again/ Hard to find materials — Neutral — Quick trip to Home Depot and I could do this again
   1 - - - - 2 - - - - 3 - - - - 4 - - - - 5

6. **How similar is the porcine eye to the human eye?**
   Not similar at all — Neutral — Very similar
   1 - - - - 2 - - - - 3 - - - - 4 - - - - 5

7. **Is there enough IOP to do the foreign body removal realistically?**
   What IOP? — Neutral — Perfect/Realistic
   1 - - - - 2 - - - - 3 - - - - 4 - - - - 5

8. **How do you like the general design?**
   Hated It — Neutral — Loved It
   1 - - - - 2 - - - - 3 - - - - 4 - - - - 5

9. **What is the relative ease of use compared to the previous bovine model?**
   Bovine eye better — Neutral — This new porcine eye is better
   1 - - - - 2 - - - - 3 - - - - 4 - - - - 5

10. **How would you rate the overall efficiency of this device?**
    Not impressed at all — Neutral — Loved it/Impressed
    1 - - - - 2 - - - - 3 - - - - 4 - - - - 5

Additional comments: ____________________

Questionnaire students completed to evaluate the apparatus.

# BREAKDOWN OF QUESTIONNAIRE RESULTS

| Point in Question | Individual Rating | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Convenience of assembly | 5 | 5 | 4 | 4 | 5 | 3 | 5 | 5 | 5 | 4 | 5 | 5 | 3 | 5 | 4 | 5 | 4 | 4 | 4 | 5 | 5 | 4 | 4 | 4 | 4 | 5 | 4 | 4 | 5 | 4 | 5 | 5 | 5 |
| Ease with slit lamp | 5 | 5 | 4 | 5 | 5 | 3 | 4.5 | 5 | 5 | 4 | 5 | 4 | 5 | 5 | 5 | 5 | 5 | 4 | 5 | 5 | 5 | 4 | 4 | 5 | 5 | 5 | 4 | 5 | 5 | 5 | 5 | 5 | 5 |
| Convenience of disassembly | 5 | 5 | 4 | 2 | 5 | 4 | 4 | 5 | 5 | 3 | 5 | 4 | 3 | 5 | 5 | 4 | 5 | 4 | 5 | 5 | 3 | 5 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Reusability | 4 | 5 | 4 | 3 | 5 | 2 | 4 | 5 | 5 | 4 | 5 | 4 | 3 | 5 | 5 | 4 | 5 | 5 | 5 | 4 | 5 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 5 | 5 | 5 | 5 |
| Reproducibility | 5 | 5 | 4 | 2 | 5 | 3 | 4 | 4 | 5 | 3 | 4 | 4 | 3 | 5 | 4 | 4 | 4 | 3 | 5 | 4 | 3 | 5 | 3 | 4 | 5 | 5 | 4 | 4 | 5 | 4 | 5 | 4 | 4 |
| Similarity to human eye | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 5 | 4 | 4 | 3 | 4 | 4 | 3 | 4 | 3 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 4 | 4 | 3 | 5 | 4 | 4 | 3.5 | 3 | 4.5 |
| Enough IOP | 4 | 3 | 4 | 4 | 3 | 3 | 4 | 4 | 5 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 4 | 4 | 3 | 4 | 4 | 4 | 4 | 4 | 2 | 5 | 4 | 4 | 2.5 | 3 | 4 |
| General design | 4 | 4 | 4 | 4 | 4 | 2 | 5 | 5 | 5 | 4 | 5 | 4 | 4 | 5 | 5 | 5 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 4 | 5 | 5 | 4 | 5 | 5 | 5 |
| Ease compared to bovine eye | 3 | 3 | 5 | 5 | 5 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 4 | 5 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 4 | 4 | 5 | 5 | 3 | 5 | 5 | 3 | 5 | 4 | 5 |
| Overall efficiency | 5 | 5 | 4 | 5 | 3 | 5 | 5 | 5 | 4 | 5 | 4 | 4 | 5 | 4 | 5 | 4 | 4 | 5 | 4 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 4 | 5 | 5 | 4 | 5 | 4.5 | 5 |

**Table I.** Breakdown of Questionnaire Scores

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