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An educational aid for the Nd:YAG laser using pig eyes

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AN EDUCATIONAL AID
FOR THE ND:YAG LASER
USING PIG EYES

By

BRIAN D. CIN

A thesis submitted to the faculty of the
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Advisor:

Kenneth Eakland O.D.
Signature Page

An Educational Aid
For The Nd:YAG Laser Using Pig Eyes

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Advisor: Kenneth Eakland O.D.
I would like to thank Dr. Kenneth Eakland, Dr. Salisa Williams, and Dr. Diane Yolton for their help in testing the eye models in their classes. It was the perfect place to find out if the models really worked.

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Brian Cin is a 1996 graduate of the Pacific University College of Optometry. He did his undergraduate work at Bemidji State University in northern Minnesota where he graduated Magna Cum Laude and earned a Bachelor of Science degree in biology. While at Pacific Brian served as the Student Optometric Association Entertainment Chair as a second year and as the SOA Vice President as a third year. He was involved in getting the AOSA conference in Portland in 1996 and was nominated for Who's Who Among Students in American Colleges and Universities. Brian was a four year recipient of the US Army's Health Professionals Scholarship Program. Upon graduation he will spend four years in the Army and then either extend his commitment or find a job in the Midwest.
Abstract

Introduction: The use of lasers in Optometry is here and expanding. The Nd:YAG laser and its use for iridotomies and capsulotomies is described. The use of a pig eye model for teaching the use of lasers was also proposed.

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Discussion: This study showed that a pig eye model is effective at teaching the use of lasers and only minor alterations are needed in the current design to increase longevity and effectivity.

Key Words: Nd:YAG, laser, teaching model, iridectomy, capsulotomy, Optometry
Introduction

As the scope of Optometry expands and the number of states with TPA laws approaches fifty the next logical step is lasers. The Nd:YAG laser is useful for many of the procedures the Optometrist may perform once laser laws pass in each state.

The Nd:YAG laser is used primarily as a photodisruptor. It works by delivering a high powered, short duration pulse within a localized area resulting in energized electrons in the target tissue. This produces a collection of free electrons and ions called plasma. Rapid expansion of the plasma creates shock waves that incise the target tissue, producing photodisruption, independent of tissue pigmentation or laser absorption.\textsuperscript{1,2,3,4}

Although there are multiple uses for the Nd:YAG laser, two are of particular use in optometry, the capsulotomy and the iridotomy.

The Nd:YAG laser is commonly used to penetrate an opacified posterior capsule following extracapsular cataract surgery in a procedure known as a capsulotomy. The capsulotomy opens a hole in the capsule, allowing a clear channel in the visual axis. The procedure does have serious complications that include cystoid macular edema, retinal detachment, and new glaucoma.\textsuperscript{5} The incidence of complications can be decreased by using lower energy pulses, post-surgical steroids, and pre- and post-operative lopodine. Laser capsulotomies are effective at removing the opacified posterior capsule and they are less invasive, have fewer complications, and have faster recoveries than surgical procedures.\textsuperscript{3,4}

Laser iridotomy is the procedure of choice in all forms of angle-closure glaucoma where a pupillary block exists. The iridotomy is usually placed in the superior nasal quadrant. This allows the upper lid to hide the hole, preventing glare and diplopia, and directs the beam away from the macula, reducing risk of inadvertent damage to the central retina.\textsuperscript{4,6} Contraindications to laser iridotomies include corneal edema and opacities that may obscure the iris and a flat anterior chamber making it difficult to keep from burning the cornea.\textsuperscript{6} The most common complications include iris hemorrhage during the procedure, increased IOP and iritis postoperatively. As was noted with capsulotomies, iridotomies are just as effective as surgical iridotomies, but are less invasive, have fewer and less severe complications, and have faster recoveries.
It is difficult to learn the effects of lasers and the methods for using lasers with paper targets. Real eyes would be more effective at learning how lasers work and seeing tissue be disrupted is more realistic than burning paper. The problem begins with the lack of volunteers that do not need the procedure and avoiding the risks and complications that can occur in a healthy individual. This study describes a technique for constructing an educational tool, using pig eyes, so that volunteers aren’t necessary to learn how to use the Nd:YAG laser.

**Methods**

An educational model was made that could be mounted in the head rest of the Nd:YAG laser. The materials and construction procedures are described within this section.

**Materials**

- pig eyes
- 10% formalin solution
- syringe
- specimen jars (diam = 2.5", hgt = 3.5") with caps
- drill with 1.5" drill bit
- styrofoam (2" thick)
- dissection kit (scalpel, scissors)
- wax
- RGP conditioning solution
- 0.25" thick glass (cut into 2" diameter circles)
- Silicone Sealant
- Styrofoam head

**Preparing the Eyes**

The pig eyes were acquired from a local slaughter house. Each eye was injected with 2cc of the 10% formalin solution and then
stored in a bath of the 10% formalin solution for 2 weeks. The formalin acts to preserve the eyes when they are in the containers.

Preparing the Containers

Use the 1.5" drill bit to cut a hole in the bottom of the specimen jar. Glue the glass disc into the specimen jar with the silicone sealant, covering the hole that was previously drilled. After the sealant has dried insure that the container doesn't leak, by filling it with water and letting it stand. Cut the styrofoam into cylinders using the jars as a template. It is suggested to delay cutting the hole for the eye until it has been dissected, as each eye is different.

Dissecting the Eye

Start by removing all the adipose tissue and any extra ocular muscle that may remain attached to the globe with the scissors. Try to leave a short length of the optic nerve in place, as it helps to stabilize the eye within the container. Remove the cornea out to the limbus, being careful not to cut the iris. At this point the lens may pop out, this is not a problem, because it can be replaced. Caution: There is pressure in the eye from the formalin injection and it may squirt out. (See Appendix A)

Constructing the Teaching Aid

Cut a hole into one of the flat ends of the styrofoam cylinder, such that the eye fits completely within the hole, and the iris is parallel with the opening. Cut a 0.25" deep valley into the side of the cylinder, this allows the removal of air bubbles, and the addition of RGP conditioning solution. Put 10 drops of conditioning solution into the hole, then place the eye into the hole, iris out. Fill the remaining space with conditioning solution. Slide the styrofoam into the container until the eye is as close to the glass as possible. Fill the remaining space around the styrofoam with conditioning
solution and remove as many of the air bubbles as possible. The air bubbles are not important unless they are on the iris. After the air bubbles are removed seal the container with wax. Once the wax has solidified the cover of the container can be replaced. (See Appendix B)

Storing the Containers

Each container was stored with the glass side facing down. This was done to guarantee that the eye was covered with liquid until it was to be used. Containers were stored for up to one year at room temperature.

Mounting the Eyes in the Laser

The containers are then inserted into a hole, that was cut to fit, in a styrofoam head. The head is taped into the head rest of the laser and it is ready to be used.

Testing the Eyes

Third year students at the Pacific University College of Optometry used the eyes in a lab for a class entitled Assessment and Management of Ocular Disease. Four eyes were used, one for each of the four labs. Each lab consisted of 18 to 24 students and each student was given as much time as they wanted to use the laser. No count was taken of number of times the eyes were lased. Each student was given a survey, which asked opinions on usefulness of the models and any improvements that could be made.

Results

The four eyes that were lased during the labs were assessed based on clarity of the solution pre- versus posttesting, ability to
perform a laser procedure, and relevance. Three other eyes were set aside to see how well they held up over time.

The solution in all four eyes remained clear for the duration of the testing and the last student got as good an example as the first. All of the students, however, had difficulty perforating the iris to make a complete iridotomy. This was remedied by increasing the laser energy beyond that necessary to penetrate the human iris and using more laser blasts. All the students did feel that the eyes were valuable for getting a real view of laser procedures. The student reports indicate that they felt the models were more "realistic" than the paper targets used previously. There were several comments on the "plume" that was easily visible during the photoablation. They also noted that the thickness of the iris made it difficult to penetrate and that a more miotic pupil may be useful.

The three eyes that were set aside to see how well they held up over time were evaluated. Two eyes were examined at one month intervals for six months. The eyes appeared unchanged, but the conditioning solution had discolored slightly (yellow) and the volume had decreased. One eye was left unused for a period of one year. At the end of the year the eye again appeared unchanged and the conditioning solution was slightly more discolored and had an even lower volume. The yellowing in all cases was extremely minimal and would not have an effect on the performance of the model. None of the eyes were removed from the containers and examined for deterioration.

**Discussion**

All the eyes performed better than was expected. The difficulty perforating the irides was due to there dilated states and greater anatomical thickness than human irides. The yellowing of the solution may have been caused by the yellow bees wax used to seal the containers or from pigment release by the iris. Although the discoloration in no way affected the visibility to the models, clear wax may prove to be beneficial to improve clarity. Loss of solution volume was due to absorption by the styrofoam. This is easily remedied by cutting into the wax and adding more conditioning solution, and resealing the hole. Extra solution can also
be added using a syringe filled with conditioning solution and injecting it through the wax and removing extra air with a second syringe or hole in the wax.

Work is currently being done to find a way to get a more miotic pupil. Miotics cannot be instilled prior to slaughter, however, we hope that enough neurologic activity is present immediately post-slaughter to allow a miotic, such as Pilocarpine, to work. Attempts are also being made to do posterior segment models, but it has been difficult to keep the retina from detaching.

## Conclusion

The teaching aid is extremely easy and inexpensive to make. The pig eye model proved to be effective for use as an educational tool. It does not in and by itself give the practitioner sufficient experience to perform the laser procedures. It does, however, work well at giving the practitioner a base for future learning.
Appendix A - Dissecting the Eye

Figure 1 - Remove all adipose tissue and any extra ocular muscles.

Figure 2 - Remove the cornea to limbus.
Appendix B - Constructing the Model

Figure 1 - Cut a hole in one end of the cylinder to fit one eye.

Figure 2 - Cut a 0.25" valley in the side of the styrofoam cylinder.
Appendix B - Constructing the Model

Figure 3 - A styrofoam cylinder with an eye and valley at the top.

Figure 4 - Front view of a completed model.
Appendix B - Constructing the Model

Figure 5 - Side view of a completed model.
Appendix C - Set-up in the Laser.

Figure 1 - The model inserted in a hole in a styrofoam head.

Figure 2 - The head and model placed in the head rest.
References


