Intraocular Pressure Reconstitution and Maintenance for Cadaveric Porcine Eyes in Simulated Wet-Lab Experience

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Background

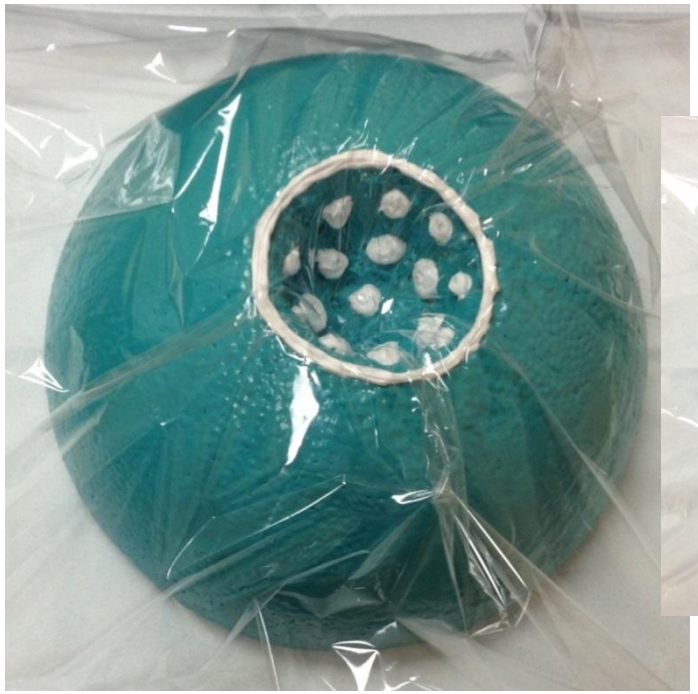
- Repetition of surgical steps generates proficiency[1].
- Simulated wet labs aid in the development of surgical skills.
- Three basic steps of ophthalmology wet labs:
  - Funding & curriculum
  - Physical space & materials
  - Repetition of skill sets
- Traditionally, in cataract surgery, sterile balanced salt solution and ophthalmic viscosurgical devices are used to form and maintain chamber depth.

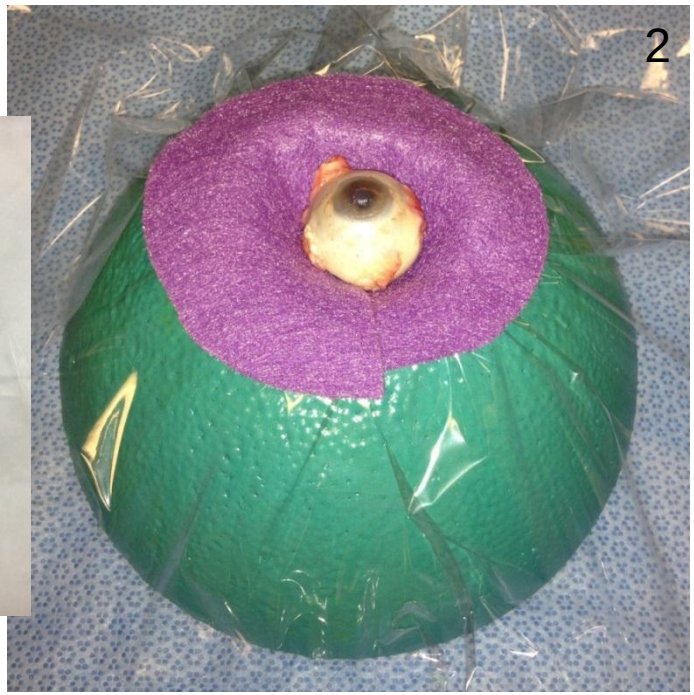
Purpose

- Anterior Segment Intraocular Surgery Wet Lab
  - Maintaining intraocular pressure
    - To determine a cost-effective way in maintaining adequate intraocular pressure in practice eyes (cadaveric porcine) in the anterior segment intraocular surgery wet lab.
    - To compare intraocular pressure and corneal clarity on these eyes which have been reconstituted with economical and easily prepared compounds (gelatin and isotonic normal saline).

Eye Stabilization Device

- A reusable eye stabilization device was created to support the pig eyes during this project. It was created from a polystyrene foam ball cut in half with the center scooped out to support the cadaveric eye. The ball was covered in acrylic paint and coated with an acrylic clear coat. Caulk sealant was used to provide a grip as well as disposable felt insert. Cellophane covered the device to aid in easy clean up. The following procedure was carried out under an ophthalmic surgical microscope.





Materials, Methods, and Statistical Analysis

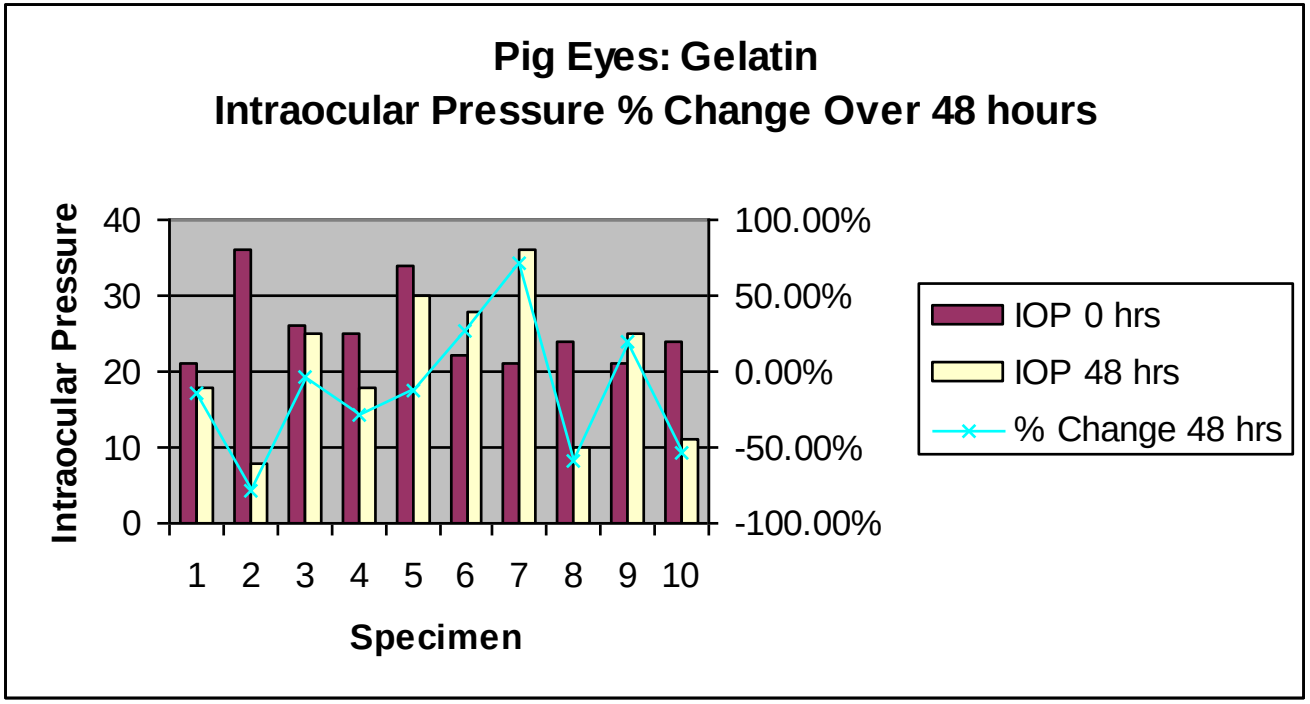
- Prospective randomized data collection in 25 cadaveric porcine eyes in May 2013.
- **Procedure:**
  - Homemade 0.9% isotonic normal saline was created using table salt and water. Standard packaged powdered plain gelatin was prepared with water and sugar and allowed to set for 1 hour at room temperature. Five ophthalmic viscosurgical devices were available.
  - On each eye, the anterior chamber was reformed via clear cornea by injecting isotonic normal saline (10 eyes), plain gelatin solution (10 eyes), or ophthalmic viscosurgical devices (5 eyes) using a 30, 27, or 25 gauge needle or cannula and syringe. Intraocular pressure (IOP) was measured by a portable electronic applanation device.
  - A clear corneal wound was constructed with a slit knife and sutured with nylon.
  - The anterior chamber was reformed to a desired IOP by feel and measured.
  - IOP was measured and corneal clarity was graded at 0, 24, and 48 hours post-procedure. Eyes were refrigerated in between measurements. Corneal opacity was graded on a scale of 0-4 with grade 0 being clear to grade 4 being opaque with no view of the pupil[3].
- **Statistical analysis:**
  - Kruskal-Wallis Test[4,5]
  - A p-value <0.05 or less was considered statistically significant.

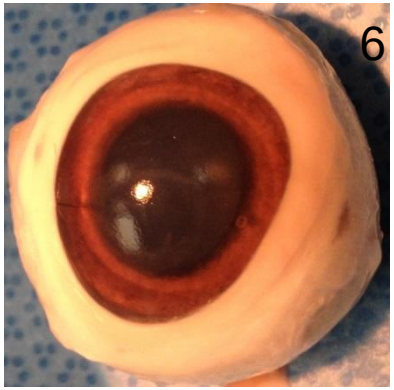
Results

- In the ten gelatin eyes, at 0 hrs (post-procedure) mean IOP was 25.4 mmHg (SD 5.2), and was maintained at 24 hrs (20.2 mmHg, SD 6.2) and 48 hrs (20.9 mmHg, SD 9.4).
- In the normal saline (NS) eyes, at 0 hrs (post-procedure) mean IOP was 20.5 mmHg (SD 8.0), and at 24 and 48 hrs IOP was unmeasurable.
- At 0 hrs, there was no significant IOP difference between gelatin and NS $p>0.05$ ($p=0.255$), but at 24 and 48 hours there was, $p<0.05$ ($p=0.000053$).

Results

- For the gelatin eyes, 70% of the time IOP decreased over the course of 48 hours.
- In all normal saline eyes, 100% of the time IOP decreased to zero over the course of 48 hours.





Results

- Unused ophthalmic viscosurgical devices were used to reconstitute the anterior chambers of five remaining cadaveric pig eyes. The cohesive and viscoadaptive OVDs were able to maintain an intraocular pressure at 48 hours.

	Specimen & Viscoelastic	**IOP Pre-Incision (reconstituted)**	**IOP 0 hours (post-procedure)**	**IOP 24 hours**	**IOP 48 hours**
	1 - Cohesive	13	13	15	9
	2 - Dispersive	26	14	12	0
	3 - Dispersive	10	17	11	0
	4 - Viscoadaptive	11	17	12	10
	5 - Viscoadaptive	17	13	9	8
Range		10-26	13-17	9-15	0-10
Mean		15.4	14.8	11.8	5.4
Standard Deviation		6.50	2.05	2.17	4.98

Results

- Corneal edema grading typically based on slit lamp examination.
- Corneal opacity scale[3]
  - Grade 0 = completely clear
  - Grade 1 = slightly hazy, iris and pupil easily visible
  - Grade 2 = slightly opaque, iris and pupil still detectable
  - Grade 3 = opaque, pupil hardly detectable
  - Grade 4 = completely opaque with no view of pupil
- Grading took place under an operating microscope for the gelatin and saline groups. Corneas were all clear (grade zero) at zero hours.

Results

- Saline and Gelatin Corneal Opacity at 48 hours
  - There is no significant difference between the two groups, $p>0.05$ ($p=0.865$).
  - Gelatin
    - Mean Opacity = Grade 2.6, Standard Deviation=0.52
  - Saline
    - Mean Opacity = Grade 2.6, Standard Deviation=0.70

Discussion and Conclusions

- An inexpensive, durable and reusable eye support system was easily created (Cost = < $10).
- Gelatin is an economical compound which maintains intraocular pressure well over time in the wet lab better than normal saline.
- Gelatin and isotonic normal saline can be easily prepared in the wet lab and are a fraction of the cost compared to commercial OVDs (1 milliliter of prepared gelatin costs less than one penny).
- The consistency and optical clarity of gelatin at room temperature is subjectively similar to OVDs when it is used approximately one hour after preparation.
- However, gelatin solidifies and sets with refrigeration, so re-using the eyes at 24 and 48 hours after refrigeration has limitations for use in the wet lab.
- Using prepared plain gelatin in place of OVDs has an application in the ophthalmology wet lab, and to the best of our knowledge with literature review, this is the first description of gelatin being used to stabilize the anterior chamber in a wet lab.

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Note: *The eye stabilization device and prepared gelatin and isotonic normal saline mixtures are not approved by the U.S. Food and Drug Administration. They were intended for wet lab purposes only on cadaveric eyes.*