Capsulorhexis Device for Cataract Surgery

Lisle Blackbourn, Molly Krohn, Sean Heyrman, Kate Howell
Advisor: Dr. Paul Thompson
Client: Dr. Jon Gunther

Abstract

-Approximately 1.5 million cataract surgeries each year in the US
-Develop a precise mechanical device that is more cost effective than the laser technique
-Instrument is to enter eye safely through 2 mm incision in cornea, unfold in eye, perform a 6mm circular cut, refold, and exit eye
-Attachment to the ultrasound machine that utilizes the vacuum setting on the Phaco-tool

Introduction

Background

-Cataracts occur when the lens in the eye becomes opaque
-The lens is positioned behind the pupil and is encased in a capsule
-Zonules attached to the case retract and relax, moving the lens to help focus the light onto the retina
-Deteriorated proteins resulting from old age make the capsule cloudy dispersing light onto the retina leading to blurry vision
-To correct cataracts, surgery is performed to replace the lens

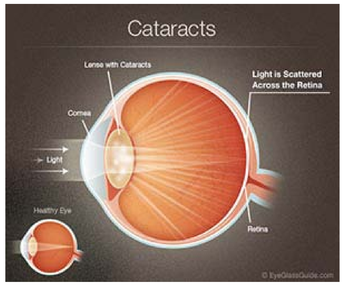


FIG. 1: Anatomy of eye shown with the effects of cataracts [1].

Current Methods/Procedures

-Capsulorhexis to access the lens
-Most common technique is continuous curvilinear capsulorhexis (CCC)
-Involves a needle and forceps to create a tear in the capsule
-Incision is made from the center out radially, tear is continued circumferentially with forceps
-Microtears may continue to the posterior side of the capsule, allowing vitreous humor to release causing surgical complications
-Laser method: no microtears but very expensive

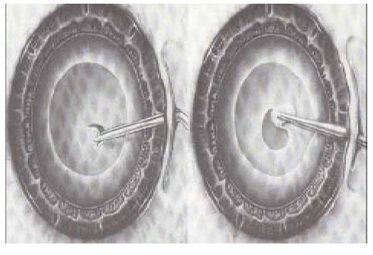


FIG. 2: Continuous Curvilinear Capsulorhexis Method [2].

Final Design

Design Criteria

-6mm diameter circular cut
-Safely enter/exit eye
-Precise size (+/- 0.5mm)

Design Features

-Suction using vacuum
-Deploys/retracts
-Circular O-ring

Market

-24,000 ophthalmologists in US
-Estimated 20,000 ophthalmologists would benefit from this device
-Based on other surgical tools, market price would be around $150

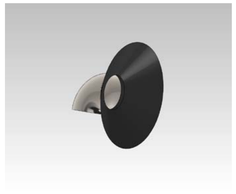


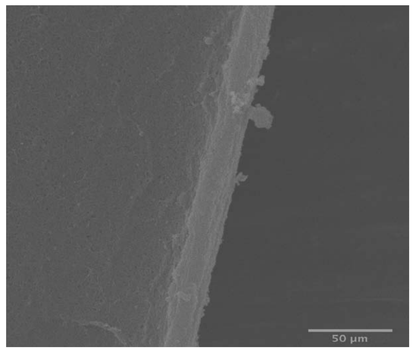
FIG. 3: Solid works model of the prototype. On the left, the pictures shows the device when it is deployed in the eye, ready to cut. On the right, the picture shows the device in its retracted state.

Conclusion

Testing

-The CCC method and our propsed vacuum method using the Phaco-tool with a 1.1mm diameter were performed on cadaver eye-balls
-Samples of the capsule cut were taken and preserved
-Using a scanning electron microscope, pictures were taken to compare the edges of both types of cuts

CCC Method



Suction using Phaco-tool

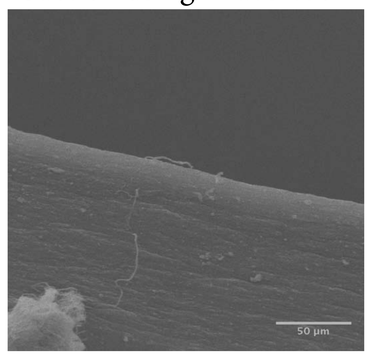


FIG. 4: Scanning electron microscope pictures of the cut capsule samples using the two different techniques. The Phaco-tool cut shows less microtears and gives a smoother cut.

Improvements / Next Steps

-Find materials with similar properties as prototype at the correct scale
-Design tip to attach properly to Phaco-tool
-Find a way to manufacture prototype to scale
-Perform capsulorhexises with device to see if the cut can be made cleanly with increased diameter
-Check edges for microtears with device
-Find appropriate range of ultrasound settings required to perform cut

References and Acknowledgements: [1] Cataract. *MedlinePlus*. http://www.nlm.nih.gov/medlineplus/cataract.html., [2] Gimbel, H.V. The History of the Capsulorrhexis Technique. Cataract & Refractive Surgery Today Europe. Special thanks to Dr. Paul Thompson, Dr. Andrew Thliveris, and our client Dr. Jon Gunther