Team 02

Artificial Corneal Implant for High-Risk Patients With Corneal Blindness

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Need

User and Problem

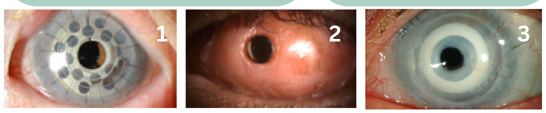
- Corneal blindness is a major cause of ocular morbidity
- Corneal transplantation is the most common treatment
- High risk patients have a low likelihood of corneal transplant success
- Keratoprosthesis (KPro) is a viable alternative

Limitations of KPros

- Invasive
- Expensive and complex
- Bad cosmetics
- Limited diffusion of nutrients

Current Solutions

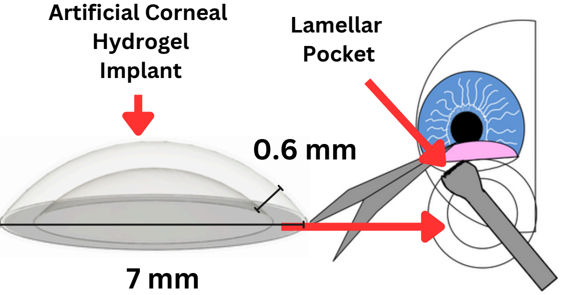
1. Boston KPro
2. Modified Osteo Odonto KPro
3. AlphaCor



Objective

Design a proof of concept, hydrogel-based keratoprosthesis device for high-risk patients ineligible for corneal transplants that improves on existing solutions by increasing implant permeability while maintaining a natural aesthetic.

Solution

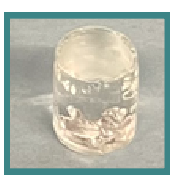


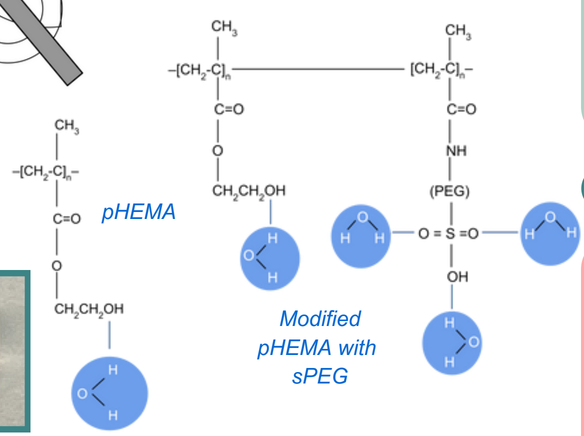
75% pHEMA/ 5% sPEG Kpro:

- Use for high-risk patients ineligible for corneal transplants
- Prevent implant rejection
- Minimially invasive surgical procedure

Both Materials:

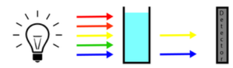
- Stable in physiological conditions
- Hydrophilic and thus compatible with biological fluids
- Exhibit minimal protein adsorption





Testing Results

Transparency Test



Requirement: ≥ 92% Transmittance

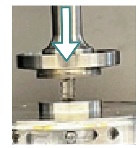
Result: 99.1% Transmittance ✓

Contact Angle Test

Requirement: ≤ 35°

Result: 25.9° ✓

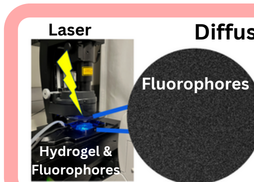
Young's Modulus Test



Requirement: ≥ 0.29±0.06 kPa

Result: 4653.8 kPa ✓

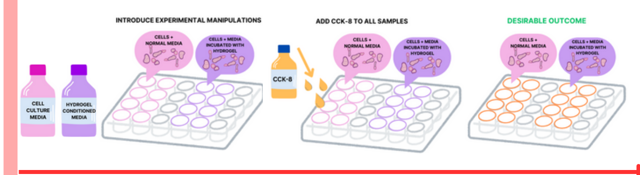
Diffusivity Test



Requirement: ≥ $3.1 \pm 1 \times 10^{-8}$ cm²/s

Result: 1.68×10^{-19} cm²/s ✗

Cell Viability Test



Requirement: ≥ pHEMA conditioned cells' metabolic activity

Result: The 5% sPEG hydrogel had significantly less metabolic activity than the pHEMA conditioned cells ✗

Conclusion and Societal Impact

Summary

This solution is the foundation to create an innovative KPro that would have fewer complications.

Future Work

- Changing crosslinker to reduce rigidity
- Changing pHEMA/sPEG concentration
- Hydrogel shaping into a dome
- Use epithelial cells for cell viability

Impact

Accessibility
Natural looking
Biocompatibility
Less complex

References and Acknowledgments

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We would like to thank our Advisory Team: Dr. Catherine von Reyn, (Co-Primary Advisor); Dr. Christopher Rodell, (Co-Primary Advisor); Dr. Jaimie Dougherty, (Design Instructor); Dr. Zeba Syed, (User/Mentor); Jay Bhatt, (Mentor/Consultant); Akari Seiner (Mentor); Arielle D'Elia (Mentor); Kenneth Kim (Mentor); and Bryce Hina (Mentor).