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Ultrasound-enhanced Drug Delivery for Treatment of Parasitic Diseases in the Eye

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Motivation

Parasitic eye diseases such as onchocerciasis are leading causes of blindness.

Current treatments require frequent application of medication to the eye.

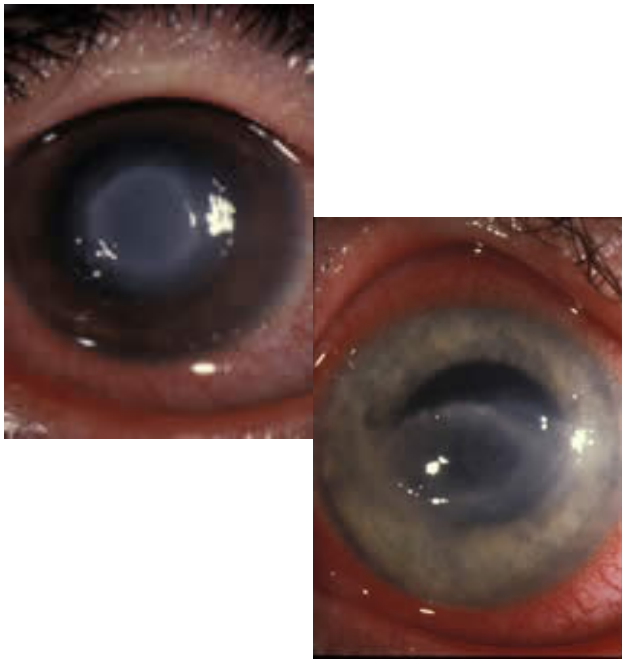
Due to the impermeable nature of the eye many treatments such as the application of eye drops fail.

Research Question

Can using therapeutic ultrasound provide a safe and effective method to treat Acanthamoeba Keratitis?

- Will this treatment improve vision preservation and healing times?

Acanthamoeba Keratitis



A rare amoeba that infects the eye from exposure to infected bodies of water or soil.

Leads to serious eye ailments such as pain, photosensitivity and blindness.

In severe cases surgical grafting of the cornea is necessary.

Figure 1: Images of Acanthamoeba Keratitis http://www.cdc.gov/parasites/acanthamoeba/health_professionals/acanthamoeba_keratitis_images.html

Hypothesis

The application of therapeutic ultrasound will lead to greater drug delivery of Polyhexamethylene Biguanide (PHMB) through the cornea.

Polyhexamethylene Biguanide (PHMB)

The corneas were exposed to a 0.02% topical solution of PHMB

A compound used in the treatment of the treatment of Acanthamoeba Keratitis.

PHMB has average molecular weight of 2400 g/mol

A hydrophilic compound with a high solubility in water (>40% w/w)

Experimental Design

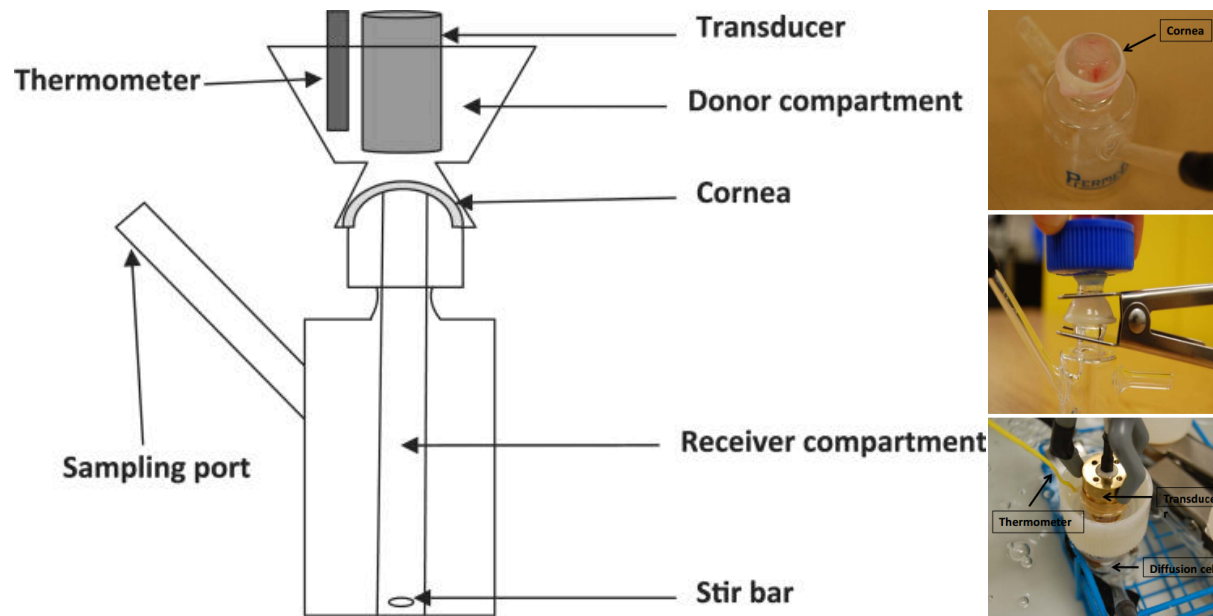


Figure 2: Diffusion Cell Experimental Setup

Transducer: Sonic concepts Un-focused, 400kHz, 15 mm Active Diameter

Methods

Ultrasound was then applied at a frequency of 400 kHz and intensity of 0.8 W/cm^2 for 5 min

Sham treated corneas were placed in the diffusion cell without application of ultrasound for 60 minutes

Amounts of the drug that penetrated through the cornea were determined through the analysis of the vertical shift of the absorbance peak at 237 nm

Results

The concentration of PHMB in the receiver compartment of the diffusion cell was $2.85 \pm 0.87 \times 10^{-5}$ % in sham-treated cases and $16.32 \pm 5.99 \times 10^{-5}$ % in ultrasound-treated cases.

Ultrasound appeared to enhanced the delivery of PHMB by 5.7 times.

One-sided t test using unequal variances: p-value of 0.03, two-sided t test using unequal variances: p-value of 0.06.

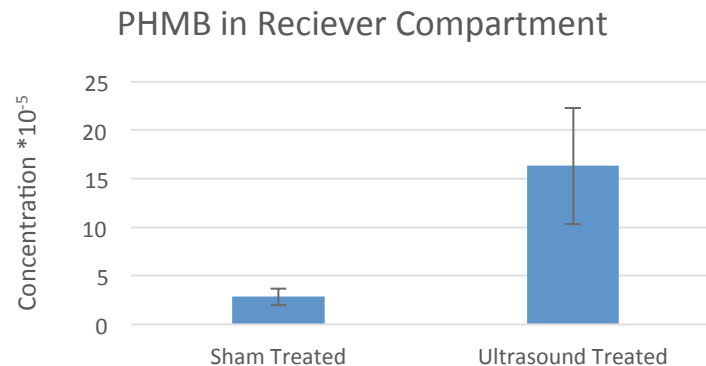


Figure 3: Experimental Results

Conclusions

The project was successful in enhancing the permeability of the cornea to PHMB by delivering 5.7 times more PHMB in ultrasound-treated cases.

Further reinforced the use of 400kHz ultrasound with an intensity of 0.8 W/cm^2 for drug delivery in the eye.

Future Work

Perform experiments using PHMB in vivo

Then develop an inexpensive ultrasound method to facilitate drug delivery to diseased eye tissues

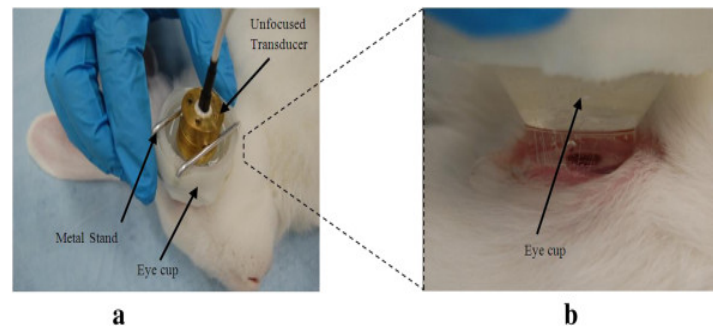


Figure 4: (a) The eye cup and transducer (b) Close-up of the eye cup

Thank You

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