Development of 3D-printed models of eyes with retinoblastoma as a leukocoria teaching aid

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Objectives:
• Accurately represent the anatomy of eyes with retinoblastoma.
• Mimic the appearance of leukocoria through a direct ophthalmoscope and digital cameras.

Retinoblastoma
• Most common pediatric ocular cancer.
• Excellent disease-free survival rate in high-income countries (95-100%), poor disease-free survival rate in low-income countries (36-77%), attributed to delayed diagnosis and treatment.[1, 2]
• Increasing early diagnosis of retinoblastoma was identified as the top research priority by a Canadian Retinoblastoma Research Advisory Board workshop in 2017.[3]
• Improving early diagnosis is critical.

Leukocoria
• White reflection (white reflex) of light from a tumour instead of red reflection (red reflex) from the retina.
• Most common initial presentation of RB.
• Often first recognized in flash photographs by parents.[4]
• Children demonstrating leukocoria are usually first examined in family practices or emergency rooms.
• All physicians should be familiar with the appearance of true leukocoria.

Model Development

REB approved for retrospective analysis of diagnostic imaging from RB patients

Select ~16 eyes spanning all stages of RB

Collect imaging data at diagnosis: MRI, CT, OCT, US, photographs

Segment MRI images to get meshes of lens, cornea, retina, tumour, etc.

Refine meshes: data from other imaging modalities

3D print or mould model eye components based on meshes

Add colour in 3D printing process

Colour painted on by hand.

Assemble 3D Model

First Models
First 3 eyes selected for segmentation, 1 eye fully segmented and first model created.

3D Model Eye Version 1
• Iris, retina, choroid and sclera 3D-printed in soft, translucent photopolymer. Colour painted on by hand.
• Cornea in hard acrylic, no lens.
• Aqueous and vitreous humours in silicone.
• Demonstrated leukocoria
• Not optically accurate
• Need to improve retinal detail and colour accuracy

3D Model Eye Version 2
• Iris, retina, choroid and sclera 3D-printed. Mixed rigid, white photopolymer with translucent photopolymer. Colour painted on by hand.
• Cornea and lens moulded in clear silicone. Exploring methods to improve optical clarity.
• Exploring optimal material for aqueous, vitreous humours
• Improved detail, colour accuracy.

3D Model Eyes for Training

We are developing 3D models of eyes with retinoblastoma to be used as teaching tools for physicians-in-training.

References