

Cooperative robotic surgical assistant for Deep Anterior Lamellar Keratoplasty (DALK)

Value proposition

In the US 40,000 full thickness corneal transplants (penetrating keratoplasty - PKP) are performed every year. There are several risks associated with this procedure, such as rejection or graft failure requiring chronic immunosuppression to manage. An alternative procedure known as Deep Anterior Lamellar Keratoplasty (DALK) exists that alleviates these risks by only replacing the epithelium and stroma, and leaving the host endothelium intact. Since the endothelium is the most cellular and immunogenic layer of the cornea, the rejection rate for DALK is zero. Moreover, graft failure is also not accelerated in DALK in contrast with PKP. The biggest barrier to widespread adoption of DALK over PKP is the high level of skill and manual dexterity required of the surgeon performing the procedure. They must remove 95% of the cornea while leaving the 10-20µm endothelial layer behind. Even in experienced hands, the failure rate for the procedure is 30%.

Technology

Researchers at Duke have designed a device for DALK that makes use of 3D visualizations of the surgical field using microscope integrated optical coherence tomography (MIOCT). A real-time interactive manipulation and viewing of static and live OCT volumes in a commercial HTC Vive® immersive virtual reality (VR) system was demonstrated. This VR OCT viewing improves upon intrasurgical heads-up displays with interactivity, full field of view display, and unrestricted head position and orientation. User was able to view the volume from any perspective through head orientation changes and walking around or through the volume. Using the interactive features, the user was able to readily apply cut planes and manipulate the volume's pose and scale. With the use of this technology, it is now possible to convert the 40,000 PKP procedures annually to DALK, and prevent the risks associated with the surgery.

Advantages

- Reduces the risk of accidental penetration of endothelium during DALK
- Allows precise visualization of instrument depth during DALK using MIOCT
- Surgeons are free from microscope oculars

Duke File (IDF)

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- Real time interactive manipulation and viewing of OCT volume

Publications

- [Draeos, M., Keller, B., Kuo, A. N. & Izatt, J. A. Immersive Virtual Reality for Live Volumetric Optical Coherence Tomography. Invest. Ophthalmol. Vis. Sci. 58, 3116-3116 \(2017\).](#)
- [PCT Patent Application # PCT/US2016/051360](#)