

**Proposal title:** Development of a clinical multi-excitation optical coherence elastography system to interrogate corneal biomechanics for the detection and staging of normotensive glaucoma.

**Category:** Medicine

**Abstract:**

In Peru, Glaucoma is the first cause of irreversible blindness characterized by progressive optic nerve damage and visual field loss. It is estimated that 50% of Glaucoma Peruvian patients are not aware they carry such a disease. The primary risk factor for Glaucoma detection is elevated intraocular pressure (IOP). However, normotensive Glaucoma (NTG) is a form of Glaucoma that develops in the eye despite its IOP being within the normal range of 12 to 21 mmHg. Therefore, early detection of NTG becomes a challenging task and it is crucial for timely intervention and preservation of vision. Currently, NTG diagnosis relies on IOP measurements through the cornea and visual field testing, which may miss the early stages of the disease. Corneas with abnormal (softer) biomechanics and topography (high astigmatism) may lead to inaccurate readings of IOP which, added to the assumptions made by each clinical tonometer, results in high variability in the estimation of IOP. Moreover, there is scientific evidence reporting that patients with NTG tend to have softer corneas compared to control patients. We propose the development of a clinical multi-excitation optical coherence elastography system to interrogate corneal biomechanics for the detection and staging of normotensive glaucoma. This system will be capable of measuring the topography of the cornea (structural B-mode frame information) and the corneal dynamic response (biomechanical information) from two simultaneous excitation sources: air-pulse macro deformation (AP-MD), and air-couple ultrasonic wave excitation (AC-US). The innovative integration of both excitation technologies together with a finite element model (FEM) of the eye will allow us to probe not only the shear modulus of the cornea through the propagation of Lamb waves, but the calculation of a true-biomechanically corrected IOP. The accuracy of the estimations of shear modulus and corrected IOP using measurements from the clinical system and the outcomes of the inverse FEM simulations will be tested using ex vivo animal models of the eye by modulating IOP with an artificial pressure-control system, and corneal stiffness with collagen enzymes. After a safety validation of the system in terms of acoustics, photonics, and air pressure for human use, a preliminary patient study will be carried out with 20 control patients, 20 patients with NTG, and 20 patients with high-tension Glaucoma (HTG). These measurements and estimations will be used to generate biomechanically inspired biomarkers of the corneal to detect early and advanced stages of NTG. We expect that shear modulus and the true-biomechanically correlated IOP can separate NTG from control and HTG patients. The impact of this research on the Peruvian ophthalmology healthcare system is fundamental since our proposed solution could catch NTG earlier and enable patient treatment to avoid further optical nerve damage and vision loss. This represents more than 80% in savings in the application of more invasive (costly) treatments and preserving vision quality. Finally, this technology can be used to understand the impact of unusual corneas (i.e., high astigmatism, low rigidity, and thin corneas) in the estimation of IOP, treatment monitoring, and the evaluation of other ocular diseases such as keratoconus.