

**ABSTRACT TITLE**

**TITLE:** OCT-Vibrography: A Novel Non-Contact Method to Estimate Corneal Biomechanical Properties

**PROGRAM # (Final ID)**

**ABSTRACT FINAL ID:** 1630 - D0265

**SESSION TYPE:** Poster Session

**POSTER BOARD # (DOI)**

**DIGITAL OBJECT IDENTIFIER (DOI):** D0265

**PRESENTATION START/END**

**SESSION ABSTRACT START TIME:** 8:30 AM

**SESSION ABSTRACT END TIME:** 10:15 AM

**SESSION # (Abbreviation)**

**SESSION ABBREVIATION:** 237

**SESSION TITLE:** Corneal Cross-linking and Biomechanics

**SESSION DAY & DATE:** Monday, May 6, 2013

**SESSION START TIME:** 8:30 AM

**SESSION END TIME:** 10:15 AM

**SESSION LOCATION:** Exhibit / Poster Hall

**AUTHORS (FIRST NAME, LAST NAME):** Sabine Kling<sup>1</sup>, Ernest Chang<sup>2</sup>, Giuliano Scarcelli<sup>2</sup>, Nandor Bekesi<sup>1</sup>, Seok H. Yun<sup>2</sup>, Susana Marcos<sup>1</sup>

**INSTITUTIONS (ALL):** 1. Instituto de Optica, Consejo Superior de Invest Cientificas, Madrid, Spain.  
2. Wellman Center, Massachusetts General Hospital, Boston, MA, United States.

## Study Group:

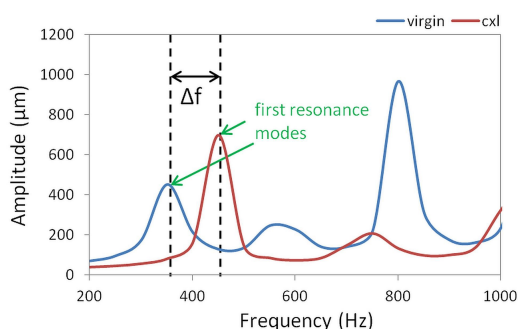
### ABSTRACT BODY:

**Purpose:** Corneal biomechanics are key for diagnosing corneal pathologies and evaluating treatments that alter corneal geometry or stiffness. Most methods to measure corneal biomechanics are destructive, while in-vivo techniques (e.g. air-puff imaging) are biased by corneal geometry and IOP. We developed a new technique to determine corneal material parameters, while reducing current prevalent restrictions.

**Methods:** Sound excitation (100-110 db) together with phase sensitive OCT was used to measure the profile of the natural frequencies (range 200-1000 Hz) in corneal tissue. The technique was tested in-vitro on 6 freshly enucleated pig and bovine eyes, using corneal flaps, corneal buttons and whole eyes. Different conditions were tested (virgin, riboflavin-dextran instillation, cross-linking CXL) to determine the effect of corneal rigidity and hydration. Changes in corneal stiffness were determined by the shift of natural frequencies and viscoelastic behavior by the phase lag between sound wave and corneal oscillation. Finite element (FE) models were built to simulate the experimental observations.

**Results:** We found an experimental shift in the first natural frequency of  $101.25 \pm 67.1$  Hz between the anterior flaps of virgin and CXL corneas; no significant shift was observed for posterior flaps ( $-12.5 \pm 32.0$  Hz). Corneal buttons and globes confirmed a frequency shift after cross-linking. The phase lag was sensitive to the tested frequency and to corneal fixation ( $\delta(\text{flap})=4.06$ ,  $\delta(\text{button})=6.19$  and  $\delta(\text{globe})=5.93$  at 355Hz). FE-models predicted the first natural frequency to be strongly correlated with corneal stiffness ( $\Delta E=+1.4\text{MPa}$ ,  $\Delta f(\text{globe})=+100\text{Hz}$ ,  $\Delta f(\text{button})=+250\text{Hz}$ ,  $\Delta f(\text{flap})=+150\text{Hz}$ ). Natural frequencies of higher modes were also sensitive to IOP, corneal curvature, thickness and density.

**Conclusions:** OCT vibrography is a promising non-invasive technique for the estimation of corneal biomechanical properties, allowing the separation of corneal stiffness from other parameters.



Shift of the first resonance frequency with increased corneal rigidity.

**Commercial Relationship(s) Disclosure:** Sabine Kling: Commercial Relationship: Code N (No Commercial Relationship) | Ernest Chang: Commercial Relationship: Code N (No Commercial Relationship) | Giuliano Scarcelli: Commercial Relationship(s);massachusetts general hospital:Code P (Patent) | Nandor Bekesi: Commercial Relationship: Code N (No Commercial Relationship) | Seok Yun: Commercial Relationship(s);Massachusetts General Hospital:Code P (Patent) | Susana Marcos: Commercial Relationship(s);Essilor:Code F (Financial Support);PCT/ES2012/070185:Code P (Patent)

**Grant Support:** Yes

**Support Detail:** FIS2011-25637; ERC-2011 AdG-294099

**Clinical Trial Registration:** No

**Other Registry Site:**

**Registration Number:**

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