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Novel approach for measuring the intraocular pressure considering the cornea biomechanical properties

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Introduction

As the direct measurement of the intraocular pressure (IOP) is an invasive intervention and implicates high risks, the IOP is commonly determined using a secondary measure which depends on individual biomechanical properties as e.g. cornea stiffness, thickness or curvature. These properties considerably influence the measured IOP in existing methods. The aim is to determine the IOP independently of individual biomechanical characteristics. A novel method using a sensor head comprising a central pressure sensor and four peripheral pressure sensors placed in a radius of 1.75 mm is proposed.

Methods

Via ANSYS© the sensor head's surface pressure as function of time and cornea radius was simulated using isotropic-elastic silicon at different Young's-modules (0.2 to 1 MPa), cornea-thicknesses (0.2 to 0.5 mm) and inner pressures of the cornea (15 to 25 mmHg). It was simulated the movement of the sensor head from a position with a distance of 0.5 mm from the cornea to 0.8 mm cornea indentation depth. The simulated sensor signals are the average pressure of the effective sensing area over time. Ideal contact between eye and sensor head was assumed. Errors (radial $\triangle r$ up to 0.8 mm, angular $\triangle \alpha$ up to 10°) in sensor positioning were simulated.

Results

The simulated signal in the central sensor exhibits the first peak, which correlates to cornea stiffness. Its asymptotical value indicates the IOP. The signal peaks of the peripheral sensors are delayed in comparison to the central sensor. The asymptotical value for the central Sensor is reached shortly after the peripheral sensors reached their maxima. This results in an applanation area of 9.6 mm^2 Differences in signal peak positions and values of the four peripheral sensors indicate positioning errors.

Conclusion

Our simulations demonstrate applicability of the proposed novel method to obtain IOPs in patients.