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Evaluation of a novel method to measure the intraocular pressure based on a mechanical eye model

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Introduction

A novel method using a sensor head consisting of one central and four peripheral pressure sensors placed in a radius of 1.6 mm is proposed for intraocular pressure (IOP) measurements. The aim of the present work is to evaluate the novel measuring method using a mechanical eye model (BiomechEye) with an exchangeable cornea and adjustable position of the sensor head against the cornea.

Methods

The different biomechanical properties of the human cornea were simulated using artificial corneas made from silicon with shore hardnesses of 0.6 and 1.0 MPa and cornea thicknesses of 0.2 and 0.5 mm. The different inner pressures in the BiomechEye (10 to 30 in steps of 5 mmHg) were emulated with a stepping motor with screw gearing and piston. Errors in sensor positioning are emulated (0.01 to 1.0 mm in steps of 10 µm) by moving the sensor head relative to the cornea via a linear table.

Results

Stiffness and internal pressure were determined by calculating the signal difference between the average peripheral and the central sensor signals. This difference signal showed a peak followed by a decline to a plateau. The value of the first inflection point is proportional to the IOP value. The difference between the peak and the followed plateau is proportional to the stiffness. Correction curves were identified according to the used corneas to calculate the correct IOP independent from the individual corneal properties. The mean IOP error was 1.8 ± 1.3 mmHg. Errors resulting from faulty sensor head positioning were detected by the characteristics of the opposite peripheral sensor. The difference between the calculated and actual position was ± 0.2 mm.

Conclusion

The measurement results show the possibility to calculate IOP taking into account the biomechanical properties of the cornea and to correct errors in sensor head positioning.