Influence of physiological parameters on IOP during physical activity – a pilot study with the EYEMATE–IO™

**PURPOSE**
Accurate measurements of intraocular pressure by clinically available methods is typically limited to static situations in standard body positions. The aim of this pilot study was to employ a novel telemetric intraocular pressure sensor (EYEMATE–IO™, Implantdata Ophthalmic Products GmbH, Hannover, Germany) for recording IOP during different body positions and physical activities.

**METHODS**
Patients previously implanted with the EYEMATE-Io were fitted with an external antenna to allow for telemetric recording of IOP during several experiments, including automatic measurements at 5 minute intervals for 24 hours (Fig. 2), quasi-continuous measurements during bicycle ergometry, different body positions and at different breathing exercises.

**RESULTS**
IOP could be recorded reliably during all settings. Measurements showed IOP to be highly dynamic with diurnal variations >20 mmHg in several. Most patients showed a marked decrease in IOP at night as well as correlation with blood pressure and heart rate. High intrathoracic pressure during forced expiration lead to reproducible increases in IOP by up to 15 mmHg, whereas low intrathoracic pressure during forced inspiration decreased IOP by up to 8 mmHg.

**CONCLUSION**
The implantable pressure sensor allows for reliable non-contact, quasi-continuous measurement of IOP during normal physical activities. This will enable detailed investigations of the effect of various physiological parameters on IOP with high temporal resolution and few technical limitations, and may lead to better understanding of dynamic IOP regulation in glaucoma.

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**Figures**
1. EYEMATE–IO™ System
   The ring-shaped sensor (left) entirely encased in flexible silicone and with an outer diameter of 11.2, 11.7 or 12.1 mm and a thickness of 0.5 to 0.9 mm is placed into the ciliary sulcus during cataract surgery (middle). The sensor is powered through electromagnetic induction via a hand-held reader device (right), which allows for non-contact measurement of IOP by the patient at his/her discretion. Up to 3000 measurements can be stored in the reader, the data can also be uploaded remotely to a secure database for viewing by the treating ophthalmologist. When fitted with an external antenna placed around the eye, automatic measurements (measuring interval 5 minutes) or quasi-continuous measurements (measuring frequency of 10 measurements per second) are possible.

2. Diurnal variation in intraocular pressure and blood pressure
   IOP was automatically measured at 5 minute intervals for two consecutive days and BP was recorded during the second day at 15 minute intervals in several patients. The graph shows values obtained in one patient with orange dots depicting IOP during the first day, blue dots showing the second day, and lines showing systolic (blue) and diastolic (red) blood pressure. There was a notable drop in both IOP and BP during the night and a sharp increase in IOP upon waking up in the morning in all 6 patients measured so far. The diurnal IOP variations appear to be highly reproducible.

3. Intraocular pressure during physical activity
   Patients IOP was measured continuously during bicycle ergometry, while simultaneously measuring ECG, heart rate and blood pressure. IOP significantly increases during physical activity synchronous to blood pressure and heart rate. In patients with high increases in heart rate, IOP increased to greater extent than in patients with minimal increase in heart rate and BP.

4. IOP changes during breathing exercises
   IOP varied in all patients to different degrees with breathing, in some cases showing IOP variations up to 2 mmHg with each inhalation/exhalation cycle during deliberate deep breathing (left). The right panel shows an enlarged excerpt from the left panel, with the dotted line showing a running average of IOP synchronous to breathing and the solid line showing the ocular pulse amplitude.

5. IOP changes during Valsalva maneuver
   Shown above are IOP changes in one patient during Valsalva maneuver (left) and inverse Valsalva maneuver (right). IOP increased as much as 15 mmHg in some patients during forced expiration and decreased by up to 8 mmHg during forced inspiration against a resistance.

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