Online monitoring and compensation of intraocular pressure for vitreo-retinal surgery

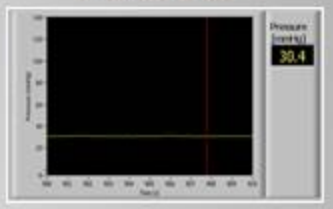
S. Ciaccia[1], A. Fassi[2], M. Piola[2], G.B. Fiore[2], G. Baroni[2], M. Soncini[2], M. Riboldi[2], F. Bergamini[1]

[1] Department of Ophthalmology, Istituto Auxologico Italiano, Milano, Italy

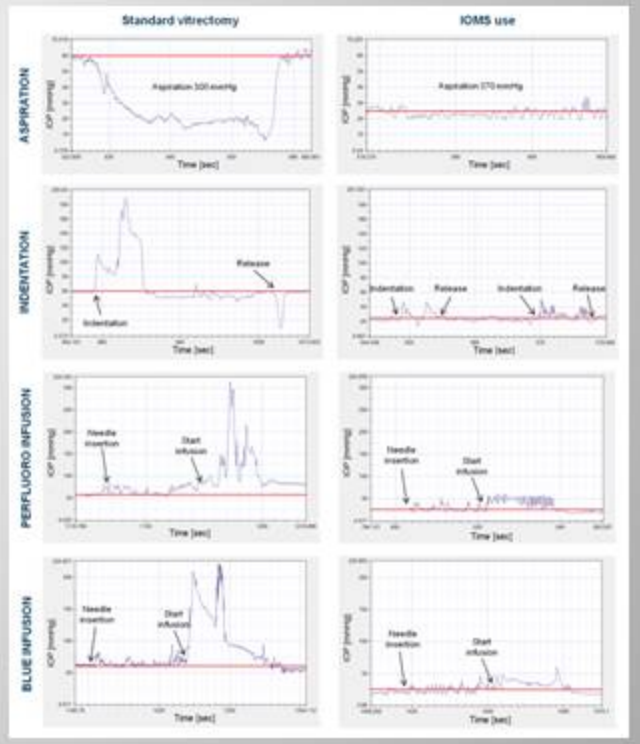
[2] Dipartimento di Elettronica, Informazione e Bioingegneria, Politecnico di Milano, Milano, Italy

Purpose: Vitreo-retinal surgery induces substantial fluctuations in intraocular pressure (IOP), which can be associated to intra/postoperative clinical complications. The aim of this study was to develop and test in animals an intraocular monitoring system (IOMS) able to directly measure and automatically compensate real IOP variations during vitreo-retinal surgery.

Methods: A standard 25-gauge 3-port vitrectomy was performed on an anesthetized porcine eye. A fiber optic pressure sensor was applied to measure IOP values during surgical maneuvers. The pressure sensor, with an outer diameter of 0.28 mm, was coupled with a 29-gauge chandelier and inserted into the eye through the 25-gauge valved trocar exploited for endoillumination. A feedback-based control system using a computer-driven peristaltic pump connected to the infusion line was used to automatically compensate IOP variations by means of fluid aspiration or infusion. The pump was controlled via PC by an *ad hoc* developed software. A three-way valve allowed disabling vitrector infusion when the peristaltic pump was turned on.



Results: During standard vitrectomy, setting 300 mmHg of aspiration without cutting caused an IOP decrease from the set-point value of 60 mmHg down to 7 mmHg (Figure 1). When the compensation function was enabled, under aspiration at 370 mmHg, the resulting IOP oscillated around the target pressure level set at 25 mmHg. After scleral indentation, IOP increased up to 189 mmHg, whereas IOP did not exceed 52 mmHg with compensation activated. The injection of external fluid during standard vitrectomy resulted in a rapid IOP increase up to 315 mmHg and 209 mmHg when perfluorocarbon and trypan blue were infused, respectively, whereas automatic compensation allowed maintaining IOP values lower than 60 mmHg under the same maneuvers.



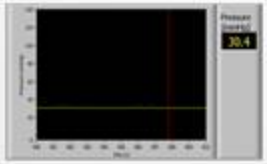
Conclusions: We proposed and investigated a new approach to provide real IOP data during vitreo-retinal surgery without requiring additional ocular incisions. Our IOMS proved effective in monitoring and compensating significant IOP variations occurring during several surgical procedures. The novel system is expected to be integrated with blood pressure measurements in order to provide a real-time estimation of ocular perfusion pressure, potentially increasing the quality and effectiveness of eye surgical treatments.

Online monitoring and compensation of intraocular pressure for vitreo-retinal surgery

S. Ciaccia[1], A. Fassi[2], M. Piola[2], G.B. Fiore[2], G. Baroni[2], M. Soncini[2], M. Riboldi[2], F. Bergamini[1]
[1] Department of Ophthalmology, Istituto Auxologico Italiano, Milano, Italy
[2] Dipartimento di Elettronica, Informazione e Bioingegneria, Politecnico di Milano, Milano, Italy

Purpose: Vitreo-retinal surgery induces substantial fluctuations in intraocular pressure (IOP), which can be associated to intra/postoperative clinical complications. The aim of this study was to develop and test in animals an intraocular monitoring system (IOMS) able to directly measure and automatically compensate real IOP variations during vitreo-retinal surgery.

CONTROL UNIT



Methods: A standard 25-gauge 3-port vitrectomy was performed on an anesthetized porcine eye. A fiber optic pressure sensor was applied to measure IOP values during surgical maneuvers. The pressure sensor, with an outer diameter of 0.28 mm, was coupled with a 29-gauge chandelier and inserted into the eye through the 25-gauge valved trocar exploited for endoillumination. A feedback-based control system using a computer-driven peristaltic pump connected to the infusion line was used to automatically compensate IOP variations by means of fluid aspiration or infusion. The pump was controlled via PC by an *ad hoc* developed software. A three-way valve allowed disabling vitrector infusion when the peristaltic pump was turned on.

Online monitoring and compensation of intraocular pressure for vitreo-retinal surgery

S. Ciaccia[1], A. Fassi[2], M. Piola[2], G.B. Fiore[2], G. Baroni[2], M. Soncini[2], M. Riboldi[2], F. Bergamini[1]
[1] Department of Ophthalmology, Istituto Auxologico Italiano, Milano, Italy
[2] Dipartimento di Elettronica, Informazione e Bioingegneria, Politecnico di Milano, Milano, Italy

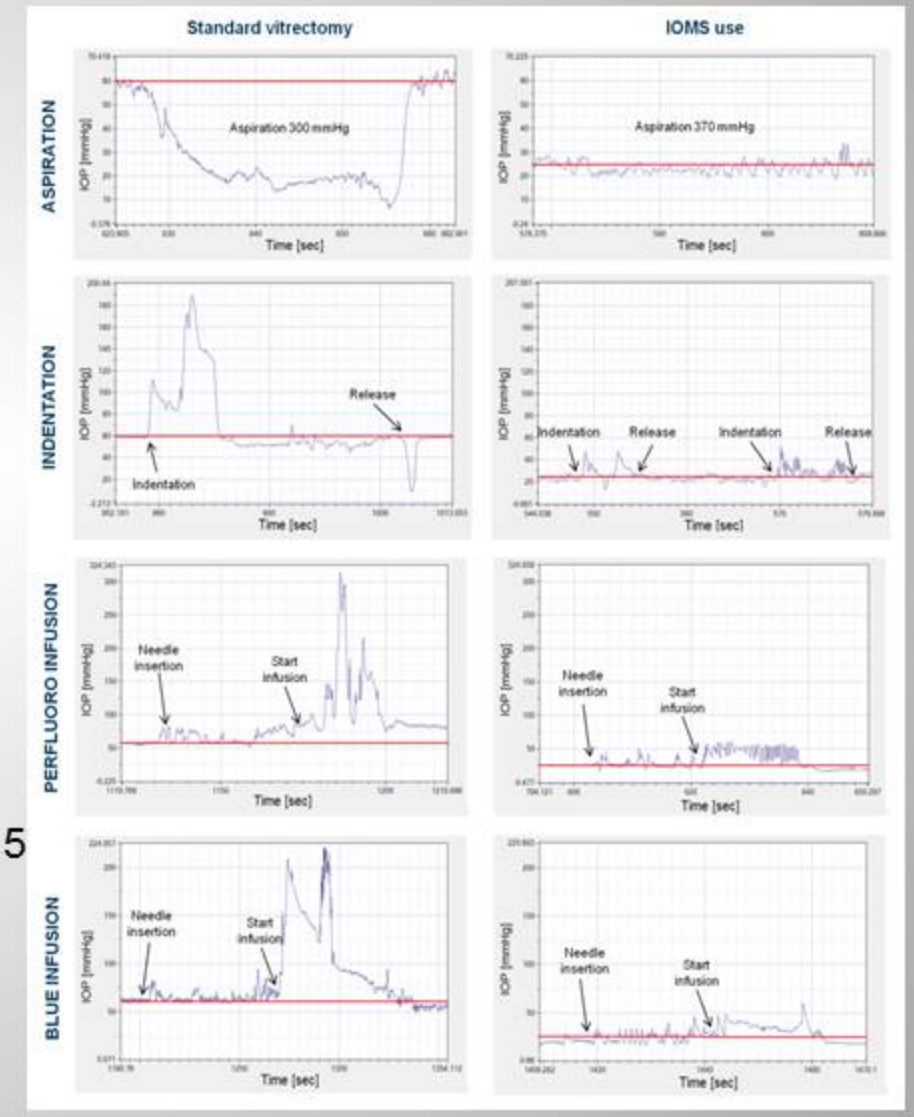
Results:

During standard vitrectomy, setting 300 mmHg of aspiration without cutting caused an IOP decrease from the set-point value of 60 mmHg down to 7 mmHg.

When the compensation function was enabled, under aspiration at 370 mmHg, the resulting IOP oscillated around the target pressure level set at 25 mmHg.

After scleral indentation, IOP increased up to 189 mmHg, whereas IOP did not exceed 52 mmHg with compensation activated.

The injection of external fluid during standard vitrectomy resulted in a rapid IOP increase up to 315 mmHg and 209 mmHg when perfluorocarbon and trypan blue were infused, respectively, whereas automatic compensation allowed maintaining IOP values lower than 60 mmHg under the same maneuvers.



S. Ciaccia[1], A. Fassi[2], M. Piola[2], G.B. Fiore[2], G. Baroni[2], M. Soncini[2], M. Riboldi[2], F. Bergamini[1]
[1] Department of Ophthalmology, Istituto Auxologico Italiano, Milano, Italy
[2] Dipartimento di Elettronica, Informazione e Bioingegneria, Politecnico di Milano, Milano, Italy

Conclusions:

We proposed and investigated a new approach to provide real IOP data during vitreo-retinal surgery without requiring additional ocular incisions.

Our IOMS proved effective in monitoring and compensating significant IOP variations occurring during several surgical procedures.

The novel system is expected to be integrated with blood pressure measurements in order to provide a real-time estimation of ocular perfusion pressure, potentially increasing the quality and effectiveness of eye surgical treatments.