AN EXPERIMENTAL MODEL TO MEASURE REAL INTRAOCULAR PRESSURE (IOP) DURING LASIK

MODELO EXPERIMENTAL PARA MEDIR LA PRESIÓN INTRAOCULAR (PIO) DURANTE LASIK

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ABSTRACT

Purpose: To design a model to measure real IOP during lasik in pig eyes.
Methods: A reusable blood pressure transducer was used. Each eye was placed on a stand with sufficient support for the surgical procedure. The globes were inflated with 5% glucosated solution through the optic nerve to attain an IOP of 10-20 mmHg. A 27-gauge catheter was then inserted from the pars plana to the anterior chamber cavity. Real IOP was transmitted via the catheter liquid column to an external sensor. A suction ring was applied and a flap was created. During the procedure, IOP was registered with the ML110 Bridge Amplifier connected to a baro transducer.

Results: Values of real IOP were measured in freshly enucleated pig eyes during the lasik procedure. The model was able to instantaneously register the changes in IOP induced by the application of a suction ring and the creation of a flap in the pig eyes with good reproducibility. At the end of the procedure the IOP values remained stable.

Conclusions: We have developed an experimental model to observe the course of suctioning and change in IOP duringLASIK surgery.
INTRODUCTION

Having a model with which IOP (intraocular pressure) can be measured in a sensitive and immediate manner when ocular surgery is performed is something useful that allows recording pressure changes induced by surgical procedures. These experiments cannot be carried out with humans for ethical reasons, thus they require developing animal models presenting sufficient anatomical similarities to human eyes.

Some authors have measured IOP during corneal refractive surgery. Bissen-Miyajima H et al. (1) developed an experimental model to observe the course of suction and changes in IOP simultaneously. Kasetsuwan N et al (2) measured actual IOP during keratomileusis and determined the variability of the flap thickness using different adjustments to the suction pressures. Sachs HG et al. (3) evaluated IOP during LASIK procedure in pig eyes using two different microkeratome systems.

In these studies the measurement system used, with some variations, was through cannulation of the vitreous chamber connecting it to a pressure sensor. Pressure values, therefore, were recorded from an area in the eye not directly affected by the surgical procedure.

This fact may give rise to certain questions about the reliability of the measurements given that the vitreous maintains a viscous consistency which hinders mobility through the liquid column used in these measurement systems.

For this reason and in order to overcome the natural disadvantages of the models previously mentioned, we decided to design a model in which IOP values were recorded directly in the anterior chamber of the eye, a space occupied by the aqueous humor, with less consistency than vitreous and more easily moved.

SUBJECTS, MATERIAL AND METHOD

In this experimental model we used enucleated pig eyes and we evaluated prospectively the changes in IOP that arose from application of the suction ring until the flap creation was finalized with a femtosecond laser (IntraLase Corp. Irvine, CA).

We used seven anatomically intact pig eyes, free from corneal damages, the latter having been verified with a slit lamp.

The eyes were insufflated with a 5% glucose solution through the optic nerve (similar to the experiment conducted by Kasetsuwan et al.) in order to obtain an IOP between 15 and 20 mmHg, confirmed with Perkins applanation tonometry (Clement Clarke, Essex, England), and placed on a surface with enough support to be able to conduct the surgical procedure.

We measured existing IOP in anterior chamber using a 27G catheter (Set ref: 387412 BD Valu-Set™) inserted intrasclerally such that it would not interfere with the application of the suction ring, and ensuring that no end of the catheter touched any intraocular structure throughout the surgical procedure.

We obtained the pressure measurements through a reusable blood pressure transducer (MLT0380 Reusable BP Transducer, Power Lab, AD Instruments, Racine, WI). The transducer is an external

Key words: Real IOP, Lasik, manometry, porcine eye, anterior chamber.

Palabras clave: PIO real, lasik, manometría, ojo cerdo, cámara anterior.
vascular pressure sensor connected (in our experiment IOP of the anterior chamber) through a catheter-fluid column present within a tube of silicone connected to the transducer. The transducer was adjusted according to the manufacturer’s instructions in order to ensure precise adherence, precise recording of IOP and elimination of any possibility of air presence in the system.

The transducer in turn was connected to an amplifier (ML110 Bridge Amplifier, AD Instruments) that instantly showed the existing intraocular pressure.

At that moment, we applied the suction ring and proceeded to create the corneal flap. All surgeries were conducted on the same day by the same experienced surgeon (JMR). During the procedure we continuously recorded IOP, right from the moment the suction ring was applied until the final moment of the cut conducted with the phemtosecond laser.

The IOP values were also recorded before and after the procedure with «Perkins» applanation tonometry. Considering that the high pressure levels present during the experiment could facilitate the evacuation path of the fluid present in the eye, we assumed that if the pressure level, after surgery, was not less than 6 mmHg it would mean there was no fluid leak that could invalidate the experiment.

**RESULTS**

We evaluated actual IOP during surgery in seven enucleated pig eyes.

The average IOP obtained during the procedure was 84.40 SD 23.83 mmHg throughout the time of eye suction and 122.19 SD 13.58 mmHg during flap creation.

<table>
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<td>5</td>
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<td>7</td>
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<td>3.18</td>
<td>112-122</td>
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**DISCUSSION**

We designed a model that allows measuring intraocular pressure during surgical procedures on the eye when subject to LASIK surgery.

The use of invasive manometry is a usual way of measuring intraocular pressure especially in animal studies. This method is presented as the most realistic way to record pressure used as a reference to assess the precision of other non-invasive means of measurement.

When reviewing existing literature, in some papers the cannulation necessary to record with...
manometry was conducted through the vitreous chamber while in others it was done through the anterior chamber.

In our opinion, both means of measurement can show considerable differences. The studies by Bissen-Miyajima H et al. (1) as well as those by Kasetsuwan N et al (2) measure IOP using a sensor inserted in the vitreous chamber.

Likewise, in an experiment conducted by Flaxel CJ et al. (4) in human cadaver eyes they proceeded in the same manner through cannulation of the vitreous chamber for manometric recording in order to prove the relation of the suction using during refractive LASIK surgery and predisposing retinal lesions with regard to a change in the axial longitude of the eye during surgery.

However, other studies conducted cannulation through anterior chamber, such as in the experiments by Lim JI et al. (5) where they compared the precision of pneumotonometry and tonometry by means of Tono-Pen, in both cases using as reference the manometry pressure measurement. Likewise, in another publication, Pasaglia CL et al. (6) also used the same cannulation procedure of the anterior chamber to gauge non-invasive measurements conducted with the Ton-Pen KL in the enucleated eyes of newborn kittens.

We must take into account that in experiments carried out with cannulation of the vitreous chamber, since a glucose solution is insufflated through the optic nerve, a certain level of vitreous liquefaction is achieved, facilitating movement of the fluid. Nonetheless, this situation certainly makes it more difficult to assume that the values obtained can be reproduced as they depend to a great extent on the level of viscosity achieved during preparation of the eye.

Our experiment holds greater similarities with the studies with cannulation in the anterior chamber, which, in our opinion, makes recording of the values obtained more reliable.

Another important aspect that provides validity to the proposed method is the fact that the final intraocular pressure is maintained within normal values, which could justify the lack of fluid leaks during the procedure, something which could have invalidated the experiment.

With our model of cannulation of the anterior chamber we were capable of recording IOP values both in the suction phase (40 SD 9.75 sec) and in the cutting phase (52.85 SD 5.66 sec). When analyzing existing fluctuations in IOP, considered as the standard deviation present in each set of measurements, it is worth highlighting a greater stability present in the cutting phase compared to the suction phase. This fact can be explained as a result of the non-manipulation of the eye by the surgeon at this phase; and on the contrary, a possible source of the existing fluctuations during the suction phase.

Even taking into account the advantages provided by this invasive method of measuring IOP during certain surgical procedures, our design is not exempt from disadvantages which should be taken into account for future improvements.

On the one hand, cannulation of the anterior chamber intrasclerally can be somewhat complicated and can lead to additional difficulties for the surgeon when placing the suction ring.

Also, another consideration to take into account is that the IOP measurement obtained may not be the one actually existing in other areas of the eye, although the physical properties of fluids indicate that the pressure exercised upon a point in a watertight compartment is directly transmitted towards all the points of that compartment. Again, the fact that the IOP at the end of our experiment was maintained within normal levels leads us to believe the eye acts as such a compartment throughout the experiment, thus transmitting the IOP values to all the points inside the eye.

Recently, Morris, CA et al. (7) compared the precision of non-invasive rebound tonometry with the IOP values obtained through cannulation in an experiment with animals related to the hypotensive effect of topical prostaglandin, demonstrating there were no statistically significant differences between either forms of measurements. Taking into account that the pressure measurement with cannulation is shown to date as the best way for an actual measurement of IOP, it is logical to believe that if we also measure it in the anterior chamber of the eye, thus avoiding the disadvantages previously mentioned of doing it in the vitreous chamber, this might prove to be the best way to note the actual pressure inside the eye.

REFERENCES

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