Correlation Between Intraocular Pressure (IOP) and Intracranial Pressure (ICP) in Dog

M. Mehdizadeh a, M. Mosallaei a, E. A. Alibai b, M. R. Razeghinejad a, A. R. Sheikhi b, M. Alirezaee c, N. Tanideh c & D. Mehrabani d

a Poostchi Eye Research Center Department of Ophthalmology
b Neuroscience Research Center Department of Neurosurgery
c Stem Cell and Transgenic Technology Research Center Department of Pharmacology
d Gastroenterohepatology Research Center Department of Pathology, Shiraz University of Medical Sciences, Shiraz, Iran

Available online: 14 Nov 2011

To cite this article: M. Mehdizadeh, M. Mosallaei, E. A. Alibai, M. R. Razeghinejad, A. R. Sheikhi, M. Alirezaee, N. Tanideh & D. Mehrabani (2010): Correlation Between Intraocular Pressure (IOP) and Intracranial Pressure (ICP) in Dog, Journal of Applied Animal Research, 38:1, 61-64

To link to this article: http://dx.doi.org/10.1080/09712119.2010.9707155

PLEASE SCROLL DOWN FOR ARTICLE

Full terms and conditions of use: http://www.tandfonline.com/page/terms-and-conditions

This article may be used for research, teaching, and private study purposes. Any substantial or systematic reproduction, redistribution, reselling, loan, sub-licensing, systematic supply, or distribution in any form to anyone is expressly forbidden.

The publisher does not give any warranty express or implied or make any representation that the contents will be complete or accurate or up to date. The accuracy of any instructions, formulae, and drug doses should be independently verified with primary sources. The publisher shall not be liable for any loss, actions, claims, proceedings, demand, or costs or damages whatsoever or howsoever caused arising directly or indirectly in connection with or arising out of the use of this material.
Correlation Between Intraocular Pressure (IOP) and Intracranial Pressure (ICP) in Dog

M. Mehdizadeh¹, M. Mosallaei¹, E.A. Alibai², M.R. Razeghinejad¹, A.R. Sheikhi³, M. Alirezaeæ³, N. Tanideh³, D. Mehrabani⁴

¹Poostchi Eye Research Center
Department of Ophthalmology

²Neuroscience Research Center
Department of Neurosurgery

³Stem Cell and Transgenic Technology Research Center
Department of Pharmacology

⁴Gastroenterohepatology Research Center
Department of Pathology
Shiraz University of Medical Sciences
Shiraz, Iran

(Received January 16, 2010; accepted May 10, 2010)

Abstract


To evaluate correlation between intraocular pressure (IOP) and intracranial pressure (ICP) 15 mature dogs were divided into three equal groups. Under general anesthesia, the IOP and ICP were determined. Group 1 received timolol, group 2 latanoprost and group 3 underwent trabeculotomy in a single eye. After 2 and 4 weeks, the IOP and ICP were measured again. Before any drug administrations or surgery, the correlation between primary IOP and primary ICP was not significant (P>0.05) but after 2 and 4 weeks, there was a considerable negative linear correlation between these two measures (r= -0.595; P=0.01) and (r= -0.570; P=0.02), respectively. There was a negative linear correlation between IOP and ICP (r=-0.67; P=0.001) when the multiple regression formula was applied to make a model.

Key words: Intraocular pressure, intracranial pressure, correlation, dog.

Introduction

The direct connection of optic nerve and the brain tissue suggests that there should be a possible correlation between intraocular pressure (IOP) in the globe and intracranial pressure (ICP) in the brain (Pasquale, 2008). Lamina cribrosa works as a junction between these two compartments and it may play an unknown role in this relation. In other words, both cerebrospinal fluid (CSF) pressure and IOP influence the laminar pressure gradient in and consequently on the optic disk surface movement. The influence of CSF pressure affects the axonal transport, which is known...
to be important in glaucoma process (Morgan et al., 2008; Pasquale, 2008).

Based on the detection of posterior compression of the globe in some patients with increased ICP in neuroimaging studies, the balance between the CSF pressure around the optic nerve and the IOP in the globe may change the position of the lamina cribrosa (Han et al., 2008). So, the papilledema may be the result of imbalance between ICP and IOP that leads to bowing of the lamina cribrosa toward the less pressured chamber, i.e. the vitreous cavity (Pasquale, 2008). Posterior bowing of the lamina cribrosa known as cupping in glaucoma patients may be another presentation of this imbalance (Pasquale, 2008). The correlation between IOP and ICP still remains un-clarified and there are controversies on the presence of any correlation between IOP and ICP (Sajjadi et al., 2006; Han et al., 2008). This study was designed to determine the correlation between IOP and ICP.

**Materials and Methods**

Fifteen mature healthy out-bred dogs (5-15 kg) provided from Laboratory Animal Center affiliated to Shiraz University of Medical Sciences were enrolled. The study was approved in the University Ethics Committee and all procedures were performed in accordance to the ARVO statement for the use of animals. In a supine position, all the dogs underwent general anesthesia using nesdonal (Sandoz, Gmbh, Kundl, Austria). The mean IOP was recorded by double measurements in both eyes and considered as a primary IOP. The animals were allocated to three groups. Group 1 received timolol (timolol, Sina Daru) one drop bid as topical antiglaucoma medication only in the right eye, group 2 received latanoprost (xalatan, Farmacia Belgium); one drop, once a day and group 3 underwent trabeculotomy in the right eye to reduce IOP. The IOP was determined using tonopen (Reichert TONO-PEN® XL Applanation) for both eyes except for group 3 where the mean pressure was recorded by double measurement of IOP in the right eye.

To measure the ICP, the hairs were clipped in the back of the head and the neck area. For a cerebromedullary approach, the landmark for midline position (the occipital protobranchise) was marked and the neck of the animal was positioned in hands and flexed up to optimal position for palpation of the space. A 22 guage needle was inserted in the midline near the cranial borders of the wing of atlas (C1). When a slight loss of resistance was determined, the needle was inserted further. A 3 way tube was connected to the needle and when a flow of CSF was observed in the tube, the CSF pressure was measured against a water column.

Trabeculectomy was performed using Watson's modification of the Cairns technique (Chen et al., 2006). First, a limbus-based conjunctival flap was prepared, the sclera was exposed and a rectangular 3x4 mm scleral flap was made. Then, a 1 mm sclerostomy was made followed by peripheral iridectomy and finally the conjunctiva was closed with a continuous 10-0 nylon suture. In the same manner, after two weeks of drug administration or surgical procedure, the IOP was measured with tonopen in the right eye. The procedure was similarly carried out four weeks later. To show the correlation between IOP and ICP, all results were sorted while ignoring the methods of reduction of IOP and also the time of measurements.

Data were analyzed with SPSS software (version 11.5, Chicago, IL, USA). Normality of data in each group was confirmed using normal probability plots. Pearson correlation test and Non-parametric Spearman correlation were used.

**Results and Discussion**

The changes in IOP in all groups and also the subsequent changes in ICP were in favor of an effective drug administration and the surgical procedure. At the beginning of the study the correlation between primary IOP and primary ICP was not visible (17.50 mmHg vs. 7.6 cmH₂O; r=0.15; P>0.05), while after 2 weeks
of drug administration and trabeculectomy, there was a considerable negative linear correlation between these two measures (11.06 mmHg vs. 11.73 cmH₂O, r=-0.595; P=0.01). Subsequently, after 4 weeks, again the results were in favor of a considerable negative correlation between IOP and ICP (10.06 mmHg vs. 11.83 cmH₂O; r=-0.570; P=0.02; Fig. 1-3). Moreover, regardless of the time of measurements and methods of reduction of IOP, there was a significant negative linear correlation between IOP and ICP (r=-0.67; P=0.001; Fig. 4). Fitting regression analysis, where ICP was the dependent variable and IOP was the continuous predictor variable, the correlation was (ICP=15.66-0.337 IOP, R²=0.448; P=0.001).

The correlation between ICP and IOP has been a subject of debate. Sajjadi et al. (2006) noticed that there was a strong positive correlation between IOP and ICP (r=0.955) and introduced IOP measurement as a reliable non-invasive procedure for evaluation of ICP in patients with neurosurgical problems. The mechanism for direct correlation of IOP and ICP was attributed to the anatomical and physiological connection between intracranial fossa and the orbit by detection of the compression of the posterior globe by neuroimaging in some patients with increased ICP. This rise of IOP, if actually happened, was a transient event with a rapid reversal to baseline since no increase in IOP was visible in response to the increase in ICP. Han et al. (2008) in 55 patients, who underwent concomitant measurements of IOP and ICP could not show any correlation between IOP and ICP and reported that IOP measurement was not a useful substitute for ICP measurement.

Berdahl et al. (2008) confirmed low ICP in high IOP states, but this study achieved high ICP in low IOP situations. There might be some unknown receptors in the lamina cribrosa that function as detectors of any changes in both IOP and ICP. Their attempts will be toward maintenance of the sum of IOP and ICP to be constant. Therefore, any reduction or elevation of either IOP or ICP would result in the inverse changes of the counterpart to hold this summation unchanged. In other words, in a case of glaucoma, while the receptors detected high IOP, they work toward reduction of IOP but because of the presence of malfunction and pathology behind glaucoma process, they could reduce only the ICP. Conversely, in the patients with low IOP, their activation would result in an increase in ICP. The same mechanism will work toward any reduction in IOP as shown in this study. This theory is not an unexpected one because of the identical function of the carotid baroreceptors responding to internal and external compressions. Moreover, according to the
In conclusion, there was a negative linear correlation between IOP and ICP when the multiple regression formula was applied to make a model. As reduction of IOP in a single eye considerably affected ICP, it is reasonable that changes of ICP in both eyes may have more effects on ICP.

Acknowledgement

The authors would like to thank the Center for Development of Clinical Research for grammar edition and Office of Vice Chancellor for Research of Shiraz University of Medical Sciences for financial support.

References


In the literature, there is a fine interconnection within dural extension to the lamina cribrosa and also the presence of some lipocalin like prostaglandins detected in this region (Killer et al., 2006; Morgan et al., 2008).

As reduction of IOP in a single eye considerably affected ICP, it is reasonable that changes of ICP in both eyes may have more effects on ICP.