Original Article

Correlation of Intraocular Pressure with Intracranial Pressure in Patients undergoing lumbar puncture

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ABSTRACT

Purpose: To determine the correlation of intraocular pressure with intracranial pressure in patients with neurological diseases.

Study Design: Descriptive correlational study.

Methods: This study was conducted in neurology department of Mayo Hospital, Lahore from 13th August 2021 to 10th November 2021, after receiving approval from ERB. Patients who never had any kind of intracranial surgery or spinal disease but endured lumber puncture because of different neurological symptoms were recruited by purposive sampling. Patients with glaucomatous nerve damage or any other disease affecting IOP, immune compromised and uncooperative patients were excluded. Intraocular pressure (IOP) of patients with raised Intracranial pressure (ICP), was measured using applanation tonometer. Data was entered in SPSS-23. Correlation analysis was evaluated by Pearson, while the p value <0.05 was considered significant.

Results: Thirty patients (n=30) including 46% females and 53% males fulfilled the inclusion criteria. The mean age of individuals was 45 years. The mean IOP of right eyes and left eyes were 14.27 ± 0.832 and 13.97± 0.786, respectively. Whereas the mean ICP was 23.40± 0.923. Intracranial pressure was neither significantly correlated with right eye IOP (p=0.707, r. =0.072), nor with the left eye (p=0.535, r=0.118,). However, a strong correlation was observed between OD-IOP and OS-IOP (r= .949, p= 0.00).

Conclusion: This study found no statistically significant correlation between IOP and ICP in patients with neurological conditions undergoing lumbar puncture. While a strong inter-eye correlation of IOP was noted, IOP measurements did not reliably reflect elevated ICP levels.

Keywords: Intraocular Pressure, Eye, Intracranial pressure, Glaucoma, Lumbar puncture.

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INTRODUCTION

Glaucoma, a chronic and progressive eye disease, is classified based on anatomy of the anterior chamber angle (open or narrow/closed), the speed of onset, and the primary or secondary nature of its cause. Chronic glaucoma is the most common form, making regular eye examinations essential for at-risk individuals to detect the condition early and prevent gradual vision loss before diagnosis.[1] It is the second leading cause of irreversible blindness, leading to a huge visual impairment all over the world.[2] The likelihood of developing glaucoma is significantly higher when the intraocular pressure increases. Normal IOP ranges from 10 mmHg to 21 mmHg.[3,4] There are many risk factors including family history of glaucoma, age, and ethnicity.[5]

An imbalance between IOP and ICP has attained significant attention in the pathophysiology of several diseases of brain and eyes.[6] The changes in ICP may affect the optic nerve head (ONH). However, its

mechanism is still unclear. It is also uncertain whether IOP and ICP work together, or both are self-regulating. In some studies, it has been recommended that these two pressures might be compensatory.[7] By the fluctuation of ICP, the lamina cribrosa can be deformed. On the other hand, ONH remodeling due to increased ICP could be counterbalancing with an increase in IOP.[7]The homeostasis of the ONH can also be disrupted by changes in ICP. ICP damages optic nerve axons, causing edema. Limited debris removal leads to harmful substance accumulation, damaging nerve fibers of RNFL and ONH.[8] Several studies have shown an association of IOP and ICP.[9] According to K-Marshall disturbance in the homeostasis of IOP and ICP, results in changes in the translaminar pressure difference (TLPD). It can ultimately lead to constant changes in the ONH.[10] Another study proposed that tonometry could be a screening method for measurement of ICP in children with brain injuries.[11] The rationale of this research was to evaluate the relationship of IOP with ICP in patients with raised ICP.

METHODS

This was a descriptive correlational study. After approval from the ethical review board of King Edward Medical University/Mayo Hospital Lahore, **(614/RC/KEMU)** all the patients fulfilling the inclusion criteria were included. Informed consent was taken from all patients. Convenient sampling technique was used to recruit patients who never had undergone any kind of intracranial surgery or spinal disease but had required lumber puncture because of some neurological diseases. Patients with glaucomatous cupping, or patients with diseases which could influence IOP were excluded. Immune compromised and uncooperative patients were also excluded. IOP of 10 mmHg to 21 mmHg was taken as normal and above 21mmHg was considered raised IOP. ICP 5 to 15 mm Hg was taken as normal, while that above 20 mm Hg was considered as Increased. ICP of all patients with neurological diseases was measured and tonometry was done to assess IOP. From 13th August 2021 to 10th November 2021, thirty patients were enrolled (n=30). Age, gender, and laterality were taken as independent variables while IOP and ICP were taken as dependent variables. Data was entered into SPSS-23 for statistical analysis. Pearson's correlation test was applied to check the correlation between IOP and ICP. P value of ≤0.05 was taken as significant. Data collection was done by using self-designed proforma.

RESULTS

Total thirty patients were enrolled (n=30). There were 53%males.Mean age was 45.33±15.1 years (range 20 to 70 years).For the right eye (OD-IOP), the mean IOP was 14.27±4.556 mmHg showing moderate variability. In the left eye (OS-IOP), the mean IOP was slightly lower (13.97±4.303mmHg). This slightly lower mean OS-IOP, as compared to the right eye was within the expected range of normal physiological variation. However, the mean ± SE of ICP was 23.40± 0.923 (SD = 5.056) as shown in Table1.

IOP was normal in 53 eyes (88%) while raised in 7 (11.6%) eyes. ICP was normal in 23% patients while in 76% the ICP was elevated. Gender based analysis showed total 10 males and 13 females had raised ICP. IOP was elevated in 3 males and 4 females. This showed that females were affected more with both types of high pressures (ICP & IOP) as compared to males. Out of 30 patients 23% had raised both IOP and ICP.

Pearson's analysis showed that ICP had a statistically insignificant correlation with IOP of both eyes. Intracranial pressure was neither significantly correlated with the IOP of right eye(p=0.707, r.=0.072) nor with that of the left eye (p=0.535, r=0.118).

Table1: *Descriptive Statistical Analysis of (Right & Left Eye) IOP and ICP.*

Variables	N	Min.	Max.	Mean		SD.	Var.
				Statistics	SE		
Age	30	20	70	45.33	2.758	15.107	228.230
OD-IOP	30	8	24	14.27	.832	4.556	20.754
OS-IOP	30	8	23	13.97	.786	4.303	18.516
ICP	30	14	32	23.40	.923	5.056	25.559
Valid N	30						

Table 2: *Pearson Correlation Test.*

		OD-IOP	OS-IOP	ICP
OD-IOP	Pearson's Correlation	1	.949**	.072
	Significant values. (2-tailed)		.000	.707
	N	30	30	30
OS-IOP	Pearson's Correlation	.949**	1	.118
	Significant values. (2-tailed)	.000		.535
	N	30	30	30
ICP	Pearson's Correlation	.072	.118	1
	Significant values.(2-tailed)	.707	.535	
	N	30	30	30

**. Correlation is significant at the 0.01 level (2-tailed).
There was a very Weak positive correlation in between IOP of both eyes with ICP. But a strong correlation is seen only between OD-IOP and OS-IOP (r= .949).

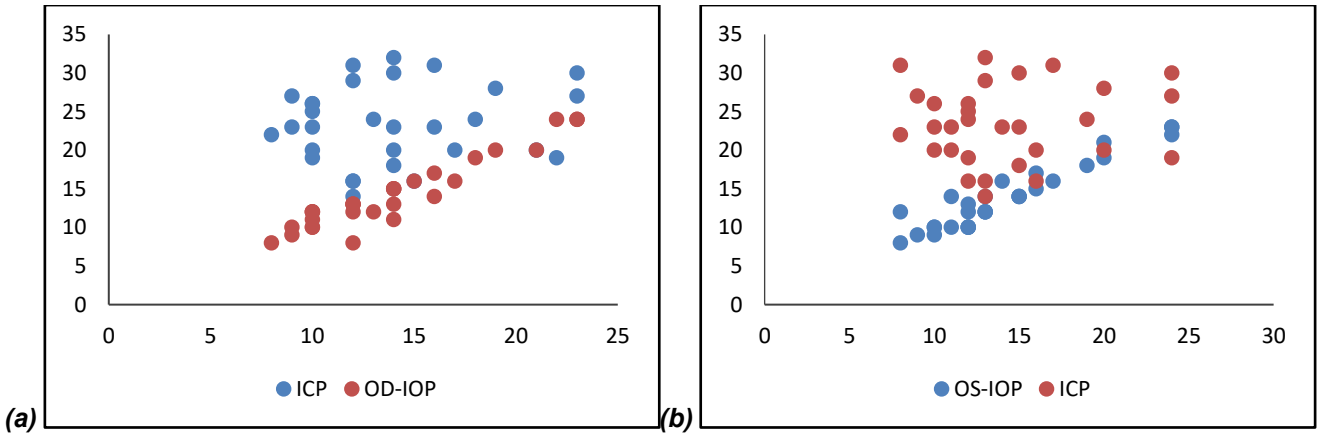

Figure 1: ICP-IOP Graph: This figure shows ICP shows no relation but IOP of right and left showing strong positive correlation in patients.

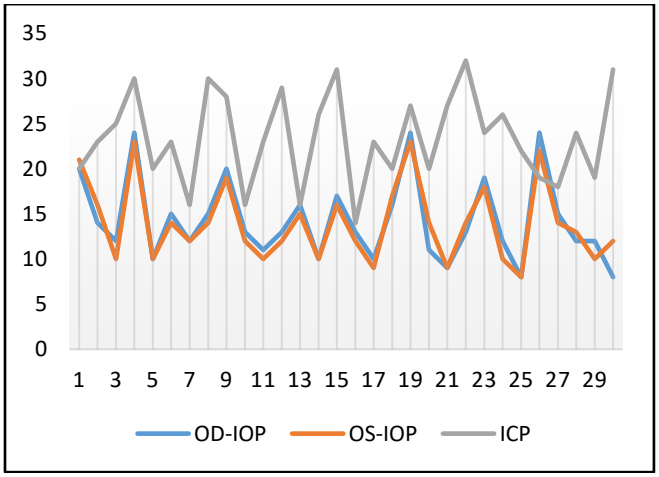

Figure 2: ICP Scattered Dot Plots with OD-IOP and OS-IOP.

The scatter graph of ICP measured values vs IOP measurements in Right (OD) and Left (OS) eyes with no significant correlation (OD_IOP*ICP: r = .072, P =0.707), (OS_IOP*ICP: r = 0 .118, P =0.535)

DISCUSSION

Glaucoma results in gradual loss of retinal ganglion cells. Therefore, early diagnosis and lifelong management are required for this chronic disease to avoid the progression of visual loss. In this study we found no significant correlation of IOP with ICP. Our results endorse earlier studies, reinforcing no significant relation between IOP and ICP[13,14] relation. In contrast to this there are some studies have shown a significant correlation between ICP and IOP.[15-17] This shows that the results are variable in different studies.[18,19]

ICP plays a significant role in glaucomatous damage and is sensitive to intraocular pressure according to some animal studies.[19] Findings from both epidemiological studies and animal models indicated that the of ICP plays a role in IOP elevation and is related to ONH damage at lamina cribrosa but its mechanism is still unknown.[20]

Sheeran et al, described link between IOP and

ICP.[21] They inspected various groups of patients with brain trauma, head injury, brain hemorrhage and brain tumor etc and established a prominent correlation between IOP and ICP. However, they found that the correlation was not statistically significant.

According to another study lowering ICP in patients undergoing microvascular decompression surgeries resulted in postoperative IOP reduction.[22] This define a directly proportion link between ICP and IOP.[22] However, they used air puff, noncontact tonometer instead of Goldman Applanation Tonometry.

Variability of the results can be due to different tonometer used in different studies. Other factors include position of the patient while recording IOP. While a handheld tonometer can measure IOP regardless of body position, it may produce over estimated or underestimated readings.[23]

Some studies have shown lower ICP in people with glaucoma as compared to the healthy individuals. Han et al found no correlation between ICP and IOP ($r = 0.07$; $P = 0.59$) and his conclusion was like our study.[24] There are other factors including instrument errors, patients' age and different criteria of patient's selection which can affect the results.

This research has certain limitations. Sample size of this study was small and there were only few patients (seven eyes) in our study whose IOP was greater than normal. IOP was measured by using Schiotz tonometer instead of Goldman Applanation tonometer.

CONCLUSION

Utilizing intraocular pressure as a noninvasive approach to monitor intracranial pressure proved unfeasible, as there was no significant correlation observed between ICP and IOP. Therefore, tonometry is not a viable option to direct ICP assessment.

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Patient's Consent: Researchers followed the guide lines set forth in the Declaration of Helsinki.

Conflict of Interest: Authors declared no conflict of interest.

Ethical Approval: The study was approved by the Institutional review board/Ethical review board **(614/RC/KEMU)**.

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Authors Designation and Contribution

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Samreen Jamal; Senior Registrar: *Literature Search, Manuscript Review.*

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Saaim Atif; Student: *Manuscript Editing, Manuscript Review.*