BIOMETRIC ASSESSMENT OF OCULAR RIGIDITY IN GLAUCOMA PATIENTS AND CONTROLS

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Abstract

Background: Biometric Assessment of ocular rigidity in Glaucoma patient’s and control: Objective; To compare oral acetazolamide induced IOP and axial length change in normal and glaucomatous subjects. Material and Methodology: The comparative study of “Biometric Assessment of ocular rigidity in Glaucoma patients and controls” was conducted after clearance from Board of Studies and Ethical committee in the Department of ophthalmology, Dr. Sushila Tiwari Government Hospital, Haldwani, Nainital during the period 2020-2022. Hundred subject (50 patients with primary open angle glaucoma and 50 control patients) underwent axial eye length measurements using partial coherence laser interferometry and measurement of IOP using Goldmann tonometry before and two hours after oral intake of 500 mg acetazolamide. Unpaired t-test was used to compare the difference in the means. Result: A significantly greater (p=0.004) drop in IOP was in glaucoma (mean=2.64) group compared with control (mean= 1.63) groups. The change in axial length was significantly smaller (p=0.02) in the glaucoma group (mean= 0.02) compared with the control (mean= 0.02). Conclusion: Our results strongly suggests that the ocular rigidity has increased in patient with glaucoma in comparison to control subjects. Ocular rigidity could play a role in pathogenesis and pathophysiology of glaucoma, determination of ocular rigidity could helpful in detection of glaucoma.

INTRODUCTION

Ocular rigidity is a biomechanical parameter of the eye expressing the elasticity of the globe. It depends mainly on the properties of the cornea, sclera and other components of the outer shell of the eye. Ocular rigidity relates intraocular pressure changes to the corresponding volume changes and is a measure of the resistance that the eye exerts to distending forces.[1] Ocular rigidity is inversely proportional to the eye volume. On the other hand, ocular rigidity is directly proportional to intraocular pressure.[2-4] In a higher pressure state, it is more elevated than in a lower pressure state. The development of non-invasive technologies for estimating ocular stiffness (OR) will have far-reaching ramifications for ocular illness research. Importantly, glaucoma continues to be a leading cause of blindness due to tremendous hurdles in both diagnosis and treatment, and its origin is unknown. The most often used clinical treatment for slowing the development of open angle glaucoma (OAG) is to reduce intraocular pressure (IOP). However, the relationship between IOP and OAG development is not clear.[5,6] Recent data from experimental research in primates and mathematical modelling shows that ocular biomechanics may play a significant role in the aetiology of glaucoma.[7-10] As per finite element modelling, IOP is a primary predictor of optic nerve head stress and strain that leads to glaucoma damage, but so does scleral elasticity and other biomechanical parameters. In fact, scleral flexibility is thought to be the most essential driver of optic nerve head stress and strain, even more important than IOP[11] implying that other variables, such as ocular biomechanics, must play a role.

MATERIALS AND METHODS

Patients visiting eye OPD diagnosed as POAG during study period time except falling under the exclusion criteria was taken as cases and controls...
was taken on the basis of matching of age and gender with respect to cases.

Inclusion and Exclusion Criteria

The study subjects were chosen as per the inclusion and exclusion criteria:

**Inclusion Criteria**

Newly diagnosed cases of POAG and control subjects except under exclusion criteria.

**Exclusion Criteria**

Unclear ocular media, High myopia (> 4 Dioptre), High hyperopia (> 4 Dioptre), Patient having anterior segment pathology, Patient having any kind of posterior segment choriorretinal degeneration and chorioretinopathy, any active infection in eye, Corneal scar, Nystagmus, Recent trauma to eye, Uveitis, Uncooperative patients, Allergic to sulfa drugs, Age less than 15, Subjects with hepatic and renal disease.

**Study Procedure**

After obtaining the informed written consent, patients were taken for comprehensive ocular examination that include best corrected visual acuity, refraction, slit lamp biomicroscopy, IOP measurement, pachymetry, posterior segment evaluation and visual field examination. Patients are divided into two groups.

<table>
<thead>
<tr>
<th>GLAUCOMATOUS SUBJECTS</th>
<th>CONTROLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selected on the basis of IOP&gt; 21mmHg with glaucoma disc changes. Only one eye is considered having more glaucomatous damage on the basis of visual field defect and optic disc changes.</td>
<td>Normal subjects whose IOP &lt;21, optic disc and visual fields are normal are considered as control. Patient presenting to eye OPD for complaints other than related to glaucoma except the subjects having the exclusion criteria. Only right eye is taken for the study.</td>
</tr>
</tbody>
</table>

Following the division of the participants into two groups, the basal axial length of the eyes of all of the subjects was measured using IOL master, and spectral domain OCT was done on both of the groups in order to observe changes in the posterior segments of both groups. Following the administration of 500 mg of acetazolamide orally to both groups, the axial length of the eye was measured using IOL Master and IOP measured using Goldmann Applanation Tonometry(GAT) after a period of two hours, and a correlation was established between ocular rigidity and changes in the posterior segment as revealed by OCT.

**Statistical Analysis**

After the data were input into the spreadsheet using Microsoft excel, the statistical analysis was performed utilising the statistical application SPSS version 21.0. The information pertaining to the quantitative variables (numerical variables) was presented in the form of the mean and standard deviation, whereas the information pertaining to the qualitative variables (categorical variables) was presented in the form of the frequency and percentage of each category. The student t-test was utilised in the process of analysing the differences in mean values between the two groups, while the chi-square test was utilised in the process of analysing the frequency differences between the two groups. If the p-value was less than 0.05, then it was considered to be statistically significant. If the p-value was greater than 0.05, then it was not.

**RESULTS**

**Table 3: Distribution of study population according to axial length**

<table>
<thead>
<tr>
<th>Axial length</th>
<th>Glaucomatous Case</th>
<th>Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std. Deviation</td>
</tr>
<tr>
<td>Pre-treatment</td>
<td>22.49</td>
<td>0.54</td>
</tr>
<tr>
<td>Post-treatment</td>
<td>22.46</td>
<td>0.53</td>
</tr>
<tr>
<td>Difference from Pre to post treatment</td>
<td>0.02</td>
<td>0.02</td>
</tr>
</tbody>
</table>

The mean pre-treatment, post-treatment and difference from pre to post treatment was compared between glaucomatous cases and controls using the unpaired t-test. The mean axial length pre-treatment, post-treatment and difference from pre to post treatment was significantly more among controls compared to glaucomatous cases.

**Table 6: Distribution of study population according to intra ocular pressure**

<table>
<thead>
<tr>
<th>Intra Ocular Pressure</th>
<th>Glaucomatous Case</th>
<th>Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std. Deviation</td>
</tr>
<tr>
<td>Pre-treatment</td>
<td>15.08</td>
<td>4.94</td>
</tr>
<tr>
<td>Post-treatment</td>
<td>12.44</td>
<td>3.65</td>
</tr>
<tr>
<td>Difference from Pre to post treatment</td>
<td>2.64</td>
<td>1.63</td>
</tr>
</tbody>
</table>

The mean intra ocular pressure pre-treatment, post-treatment and difference from pre to post treatment was compared between glaucomatous cases and controls using the unpaired t-test. The mean intra
ocular pressure pre-treatment, post-treatment and
difference from pre to post treatment was
significantly more among glaucomatous cases
compared to controls.

DISCUSSION

Ocular rigidity is biomechanical parameter of the
eye expresses the elasticity of the globe. It
depends mainly on the properties of the cornea,
sclera and other components of the outer shell of
the eye. Ocular rigidity relates intraocular pressure
changes to the corresponding volume changes and is
a measure of the resistance that the eye exerts to
distending forces. Accumulating clinical and
scientific evidence has confirmed the critical roles
of biomechanics in ocular health and disease,
specifically in glaucoma.12-15 Glaucoma is the
second leading cause of blindness worldwide,16 and
represents a significant health and financial burden
on the economy. Glaucomatous axonal damage
initiates at the optic nerve head (ONH) where the
retinal nerve fibers (axons of ganglion cell) exit the
eye.17,18 Mathematical modelling and animal
studies have suggested that scleral stiffness is a
major determinant of the ONH susceptibility to the
damage.19

Axial Length

On pharmacologically inducing IOP change effect
on axial length in glaucomatous eye and healthy eye
we have found that lesser axial length change in
glaucomatous group as compared to controls (healthy individuals) group suggestive of
greater ocular rigidity in glaucomatous patients as
compared to controls.

Ebneter et al demonstrated an identical drop in IOP
was induced in both the glaucoma (mean±SEM:
2.90±0.44mmHg, n/419) and the control group
(mean±SEM: 3.17±0.32mmHg, n/423). The change
in axial eye length was significantly smaller
(P/0.026) in the glaucoma group (mean±SEM:
14.2±3.2 lm, n/419) compared with the control
group (mean±SEM: 23.0±2.98 lm, n/423). Results
strongly suggest that the ocular rigidity is increased
in patients with established glaucoma in comparison
to control subjects.20 Ocular rigidity could play a
role in the pathogenesis and pathophysiology of
glaucoma. Determination of ocular rigidity could be
helpful in detection of glaucoma.20

In our study we found that after inducing IOP fall
pharmacologically the change in axial length was
significantly smaller (p=0.022) in the glaucoma
group (mean= 0.02) compared with the control
(mean= 0.02). Our results were suggestive of
increased ocular rigidity in the glaucomatous group
compared to control group. The results of our study
were similar to Ebneter study.

Intra Ocular Pressure

The mean IOP Pre-treatment, Post-treatment and
difference from Pre to post treatment was
significantly more among glaucomatous cases
compared to controls. A significantly greater
(p=0.004) drop in IOP was in glaucoma
(mean=2.64) group compared with control (mean=
1.63) groups. Friedenwald JS et al. found that ocular
rigidity describes the change in intraocular pressure
(IOP) in response to a change in ocular volume. The
ocular volume fluctuates due to the pulsatile
vascular filling that occurs with each heartbeat, and
for a given volume change, stiffer eyes will have a
correspondingly larger increase in IOP, and vice
versa for less stiff eyes.21 Findings were similar to
our study.

In Ebneter et al. on pharmacologically inducing IOP
drop, an identical drop in IOP was induced in both
the glaucoma (mean±SEM: 2.90±0.44mmHg, n/419)
and the control group (mean±SEM:
3.17±0.32mmHg, n/423). Our findings were different
as significantly greater (p=0.004) drop in IOP was in
glaucoma (mean=2.64) group compared with
control (mean= 1.63) groups in our study.

CONCLUSION

Our results strongly suggests that the ocular rigidity
has increased in patient with glaucoma in
comparison to control subjects. Pliability of ocular tissue is increased to bear the raise pressure. If see it in reverse manner increased ocular rigidity could be one of the cause of glaucomatous damage. So, ocular rigidity could play a role in pathogenesis and pathophysiology of glaucoma, determination of ocular rigidity could helpful in detection of glaucoma.

REFERENCES


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