ORIGINAL RESEARCH PAPER

Ophthalomology

KEY WORDS: color doppler imaging (CDI), Primary open angle glaucoma (POAG), Ophthalmic artery (OA), Central retinal artery (CRA), End diastolic velocity (EDV), Peak systolic velocity (PSV), Resistivity index (RI)

ROLE OF COLOR DOPPLER IMAGING IN PRIMARY OPEN ANGLE GLAUCOMA

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ABSTRACT

PURPOSE- To assess the blood flow velocity by color doppler imaging (CDI) of retrobulbar vessel in eyes with primary open angle glaucoma (POAG) .**METHOD-** A prospective case control study was done on 40 newly diagnosed POAG patients and 40 control patients with no clinical evidence of glaucoma. Color doppler imaging was performed by ultrasound machine using linear high frequency probe. The color doppler window was localized over the retrobulbar area and flow in the ophthalmic artery (OA) and central retinal artery (CRA) identified, Peak systolic velocity (PSV) and End diastolic velocity (EDV) values for both the vessels were obtained. Resistivity index (RI) was calculated as (PSV-EDV)/ PSV. **RESULT-** The study sample consisted of 40 patients in the POAG group and 40 patients in the control group. All the patients with POAG had raised RI and decreased EDV in both the OA and CRA. Also RI was raised in 45% patients with stable normal visual fields in POAG group. The increase in IOP in POAG group was negatively correlated with PSV and EDV and positively correlated with RI for both the OA and CRA. **CONCLUSION-** Despite normal visual fields, retrobulbar hemodynamic alterations contribute to progression of glaucoma in early stage. Early diagnosis of glaucoma can be achieved by using CDIs of ocular blood flow, which enable early intervention to prevent progressive irreversible vision loss.

INRODUCTION-

According to the World Health Organization (WHO), primary open angle glaucoma is the leading cause of preventable irreversible blindness in the world.(1,2)

This condition results from irreversible loss of retinal nerve fibers in the optic nerve (ON), caused by optic neuropathy. Years before visible changes in the visual field (VF) are noticed, glaucoma axonal loss occurs [3,4]. In order to prevent progressive vision loss, early diagnoses of glaucoma are crucial. Optic nerve damage caused by glaucoma can occur even when there is no increase in intraocular pressure.

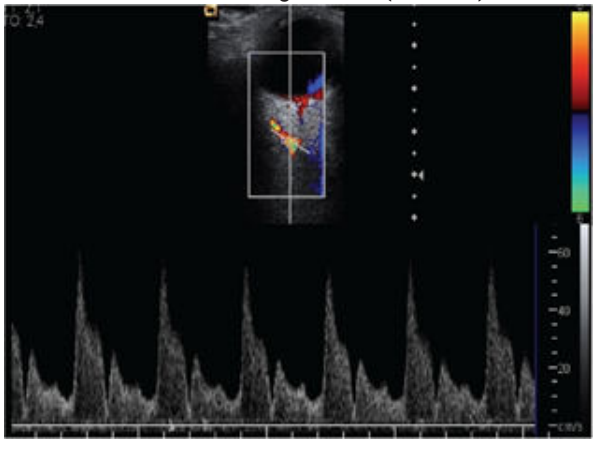
Color Doppler Imaging (CDI) can be used to evaluate early changes in vascular flow related to glaucoma due to its direct relationship to retrobulbar circulation [5, 6].
An ultrasound is a classic diagnostic tool for assessing ocular pathology morphologically [7,8]. In pathologies like glaucoma, whose pathophysiology appears to involve vascular factors, the ability of Doppler ultrasound to obtain quantitative measurements of vascular flow opens up a new range of diagnostic possibilities, allowing statistical analysis with a greater degree of diagnostic discrimination. [9-11].

METHOD-

This is a prospective case control study conducted on 40 newly diagnosed POAG patients (POAG group) and 40 control patients (control group) with no clinical evidence of glaucoma. Before participation in the study, subjects gave full informed consent to the procedures. Cigarrete smokers , diabetics, hypertensives were excluded from the study. Also patients with cataract and corneal opacity precluding posterior segment assessment were excluded.
After a standard ophthalmological examination, the diagnosis of POAG was based on the presence of glaucomatous optic nerve head damage on fundoscopy (78D slit lamp bio microscopy), characteristics glaucomatous visual field defects (Humphrey Field Analyzer), raised IOP > 22 mmHg (Goldmann applanation tonometer) on 2 occasions at different time of day and open anterior chamber angles on gonioscopy (Goldmann 3-mirror lens).

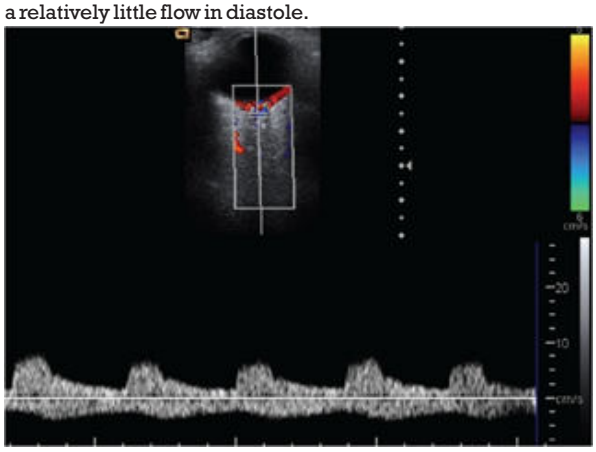
All of the subjects underwent ocular colour doppler imaging while lying on their backs with their eyes closed and looking up at the ceiling. A thick layer of gel was applied to the closed eyelid, and a 9Mhz linear array transducer was placed on the temporal portion of the closed upper eyelid with the examiner's hand resting on the orbital margin to reduce pressure on the globe. Color flow mapping was used to initially identify the vessels, and the doppler gate was then used to interrogate them in order to provide a spectrum waveform and hence quantitative data.

The central retinal artery(CRA) and the ophthalmic artery (OA) were imaged by the color doppler ultrasonography in all the subjects. To examine the OA, the sample volume was oriented nasally and superior to the optic nerve, OA is just lateral to and above the visible hyporeflective stripe representing the nerve, while the CRA was imaged in the shadow of the optic nerve, the sample volume was placed 3mm behind the surface of the optic disc.(12) The peak systolic velocity (PSV) and the end diastolic velocity (EDV) values were obtained. Two readings of each artery were obtained and the average was taken. RI was calculated from the following formula-(PSV-EDV)/ PSV.



Transverse color Doppler image that demonstrates the location of the ophthalmic artery (OA), medial to the optic

nerve (ON), and the typical OA waveform obtained by pulsed Doppler that shows a sharp systolic peak, a dicrotic notch, and a relatively little flow in diastole.



Transverse color Doppler image showing the central retinal artery (CRA) and central retinal vein (CEV) in the center of the ON.The typical waveforms for central retinal vessels show the CRA curve above the zero axis (with rounded systolic peak and continuous flow during diastole)

RESULT-

The study sample consisted of 40 patients in the POAG group and 40 patients in the control group The age range for POAG cases was 55-80 years , while for the control group was 40-80 years. Sixty four (80%) of the glaucoma patients were male and sixteen were female (20%).

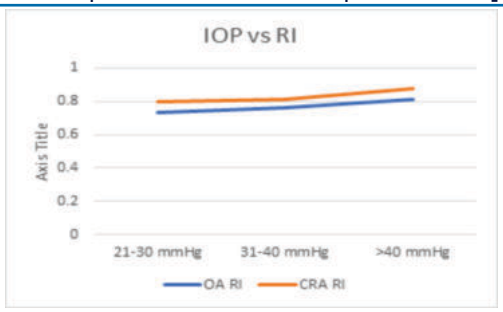
The range of PSV and EDV for both OA and CRA were faster in the control group as compared to the range in the POAG group. The RI range of CRA in POAG group was 0.67-1.05; while in control group the RI was in range 0.54-0.65 . The degree of resistance to flow in OA was significantly higher than that in the control group.

The mean PSV(cm/sec) in the CRA of the POAG group was 11.40+-1.83 as compared with 14.17 +- 2.63 in the control group. The mean PSV(cm/sec) in OA of POAG group was 31.35+-3.74 as compared with the mean PSV of 37.61+-5.37in the control group. The mean EDV(cm/sec) of 3.51+-0.9 obtained from the CRA of the POAG group was also significantly lower than the corresponding value of 5.57+-1.38 obtained from the control group. Mean EDV (cm/sec) of 9.06+-2.33 in the OA of the POAG group was slower than the 13.86+-2.86 obtained for the OA of the control group.

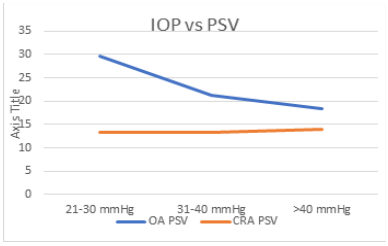
Table 1 – Range Of Ocular Blood Flow Velocity And Resistive Index In Patients With POAG And Control Group.

DOPPLER PARAMETER	POAG GROUP	CONTRO L GROUP
CRA	Range	Range
PSV (cm/sec)	-14.6 – 14.8	10.2-20.5
EDV (cm/sec)	-1.6 – 6.7	3.5 -8.2
RI	0.67-0.88	0.53-0.65
OA		
PSV (cm/sec)	9.68 -47.2	24.64-53.5
EDV (cm/sec)	-0.44-14.2	9.5-19.6
RI	0.65- 1.05	0.54-0.68

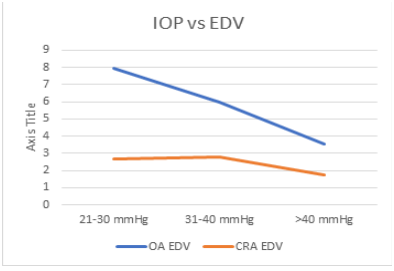
A high negative correlation was recorded between the IOP and PSV of OA in POAG group. A significant positive correlation between IOP and RI in the POAG group was found in OA and CRA, similarly the EDV values correlated negatively with the IOP values in the OA of the POAG group. There was negative correlation of the values obtained for PSV and EDV in the CRA of POAG group in comparison with IOP values.



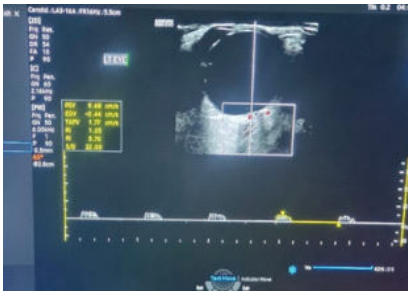
Resistive index and IOP in CRA and OA of POAG.



Relationship between PSV and IOP in the CRA and OA of POAG .

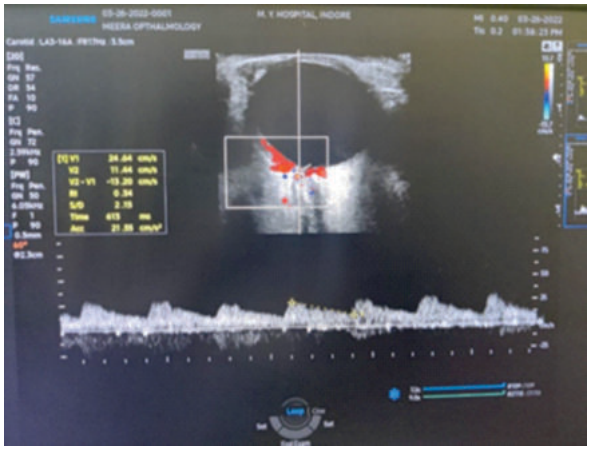


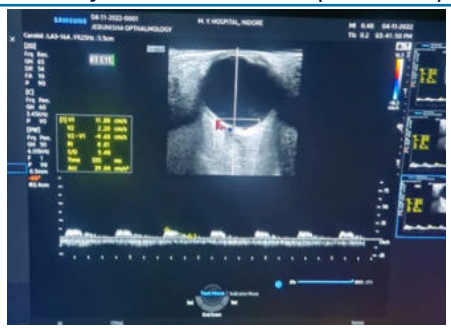
Relationship between EDV and IOP in the CRA and OA of POAG.



Transverse color doppler image showing normal OA waveform .

PSV -24.64 cm/sec
EDV-11.44 cm/sec
RI-0.54
RI-1.05





Transverse color doppler image showing CRA waveform in POAG
PSV-11.88 cm/sec
EDV-2.20cm/sec
RI-0.81

Transverse color doppler image showing normal CRA waveform.
PSV- 11.5cm/sec
EDV-4.2cm/sec
RI- 0.64

DISCUSSION-

The alteration in OBF dynamics is well recognized in glaucoma. Many studies over the last twenty years have shown that vascular factors may play an important role in glaucoma pathogenesis due to an OBF autoregulation failure [13, 14]. Moreover, although elevated IOP is a well-known major risk factor for glaucoma, it has been demonstrated that there are numerous patients in whom glaucoma progressed despite an IOP therapeutic reduction [15, 16], so IOP is a poor progression marker. Doppler US has been recognized in many papers as an effective tool to assess alteration in these flow dynamics.(17,18).

In the present study significant differences were found for orbital CDI parameters between both groups. Significantly slower mean blood flow velocities (PSV,EDV) were recorded in the OA and CRA of POAG group as compared with the control group in this study. This finding is similar to a previous report by Rojanapongpun et al., who reported slower mean PSV and EDV of the OA in comparison with the control group.(19) . Mokbel et al., studied ocular color doppler imaging of CRA in Egyptian patients with POAG and found slower EDV in the POAG group as compared with the control group subject in the same population.(20).

RI has the advantage that its value does not depend on Doppler angle contrary to PSV and EDV ;this is because RI is a ratio and hence its absolute value can be used for comparison of results among different studies since values are constant irrespective of Doppler angle change. The increase in RI in both OA and CRA in glaucoma as compared to the control group have been reported previously. High RI implies an increased peripheral resistance to flow in causing direct impedance to blood flow in the retinal circulation. Increased RI in glaucoma patients caused by longstanding raised IOP that caused direct impedance to blood flow in the retinal circulation. This is consistent with our finding of positive correlation between IOP and RI in OA and CRA of POAG in the current study.

Limitations of this study is that the measurement of ocular blood flow velocity was restricted to OA and CRA alone , thus excluding the parameters in the posterior ciliary vessels, also we could not assess the effect of antiglaucoma medications and the effect of lowering IOP on the blood flow parameters.

CONCLUSION-

POAG patients often exhibit altered ocular circulation, indicating a role for vascular factors in glaucoma pathogenesis.

A measure of ocular blood flow in POAG patients may be useful in determining the extent of damage as well as monitoring progress of the disease.

When retrobulbar hemodynamics are still normal in early stages and when classical risk factors such as IOP are not altered, orbital CDI would prove to be an important diagnosis method, whose result could guide us in conflicting cases to adopt more or less aggressive measures.

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