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Original Research Article

A CLINICAL STUDY OF HYPERMETROPIA AS A RISK FACTOR IN ANGLE CLOSURE GLAUCOMA

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Abstract

Background: Primary angle closure glaucoma (PACG) represents an ophthalmic emergency. PACG has been associated with many risk factors, including ethnicity, age, and sex, contributing to the prevalence. Recently hypermetropia (HM) has been reported as a risk factor for PACG. Hence, the present study was performed to study hypermetropia as a primary angle closure glaucoma risk factor. **Materials and Methods:** The present prospective and analytical study was performed on patients who attended the Out Patient Department of Ophthalmology (OPD), Thanjavur Medical College & Hospital, from December 2017 to May 2019. The various risk factors of PACG, such as age, sex, occupation, refraction, axial length, anterior chamber depth (ACD), K1, K2, Gonioscopy, field defects, neuroretinal rim (NNR) thinning, Cup-disc ratio, intraocular pressure (IOP) in both eyes were evaluated for HM only (n=54) and HM+ PACG (n=27) patients. **Result:** Maximum patients 37 (45.7%) were observed in the age group of 40 to 50 years. 31.5% of patients with only HM were more than 50 years old, and 47 (50.57%) female predominance was reported. Parameters such as age in years, refraction, Axial length, ACD, cup and disk ratio, NNR thinning, field defect, Gonioscopy, K1, IOP in both eyes and K 2 in the right eye showed significant ($p<0.05$) between HM only and HM + PACG patients. **Conclusion:** The study concludes that hypermetropia is a risk factor for PACG, and importantly, increased public awareness and health education in outpatient departments are essential in the early detection and treatment of glaucoma in Hypermetropic patients.

INTRODUCTION

Glaucoma stands as a prominent contributor to irreversible blindness on a global scale.[1] This condition is characterised by optic neuropathies that induce distinctive structural changes at the optic nerve head. These changes lead to the degeneration of retinal ganglion cells and their axons, ultimately causing visual field loss and eventual blindness.[2,3] In contrast to primary open-angle glaucoma, the prevailing form of glaucoma, primary angle closure glaucoma (PACG), involves the closure of the anterior chamber angle of the eye. This glaucoma is associated with a higher likelihood of bilateral blindness, burdening families and society.[4,5] According to reports from 2020, the prevalence of PACG globally was estimated to be 23.36 million, and this number is projected to increase to 32.04 million by 2040. Most PACG cases are concentrated in Asia, accounting for over three-quarters of the affected population.[6] Numerous population-based studies have identified a range of risk factors for glaucoma, with hypermetropia (HM) being one such factor.[7,8] This increased risk may be attributed to the changes in biometric parameters commonly seen in HM patients, potentially making them more susceptible to glaucoma development.

More patients with chronic angle closures have no significant symptoms. Most patients have lost their vision before presenting to the hospital. Case detection in the outpatient department is perhaps the best approach. Improved detection with simple tests like the flashlight test, von Herrick's test and confirmation on gonioscopy play a key role in diagnosis.[9] The ophthalmologist should approach each case of hypermetropia separately, considering the patient and his family history, degree of visual field defect, and records if available and keep the patient under long-term follow-up.[7]

PACG is one of the highly prevalent ocular diseases in Asian countries. Chronic angle closure is the most frequent type, which is more insidious and often missed. Early interventions can prevent further damage. So, it is very important to know more about the pathophysiology and risk factors for PACG to improve prevention.[10] Hence, the present study was

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performed to study hypermetropia as a primary angle closure glaucoma risk factor.

MATERIALS AND METHODS

The present prospective and analytical study comprises 93 patients aged 30 years and above who attended the Outpatient Department of Ophthalmology (OPD) at Thanjavur Medical College & Hospital from December 2017 to May 2019. Written informed consent and institutional ethical committee approval were taken before the study started.

Inclusion Criteria

All patients of either sex, aged over 30, and who agreed to sign the consent form were included.

Exclusion Criteria

Patients under 30 who refused to sign the consent form were excluded.

Clinical Procedures and Investigations

- Visual Acuity: Vision, both unaided and aided, was tested using Snellen's visual acuity chart.
- Automated Refractometer: Auto Ref Keratometer Accuref-K 9001 was used to obtain the objective refraction.
- Near Vision Assessment using Jaeger's chart
- Slit Lamp Examination to rule out secondary causes of glaucoma
- Gonioscopy: In this study, Goldmann's three-mirror gonioscope was used to view the angle structures and the angle was graded using Shaffer's grading system.
- Ultrasound A-Scan was used to measure axial length and anterior chamber depth.
- Keratometry values were done with an automated refractometer (Auto Ref Keratometer Accuref-K 9001)
- Intraocular pressure (IOP) with applanation tonometry: All patients were called for intraocular pressure (IOP) measurement three times a day, and an average of 3 measurements were taken up for the study purpose. Whenever necessary, patients were started on treatment or advised of long-term follow-up.
- Direct Ophthalmoscopy All the patients were examined with a direct ophthalmoscope in this study.
- Indirect Ophthalmoscopy: The Heine binocular indirect ophthalmoscope with a lens strength of + 20 D was used. Patients were examined with pupils fully dilated and supine in a dark room. Fundus examination using a Volk 90D lens (correction factor 1.3) and slit lamp.

Glaucomatous optic nerve head changes were diagnosed based on the following criteria: Cup disc ratio asymmetry, supratemporal or inferotemporal notching, localised retinal nerve fibre layer thinning, disc haemorrhage without any other cause for disc haemorrhage.

- Automated Perimetry All patients were subjected to visual field tests using the Octopus G1 program, dynamic strategy. A new classification was used to consider visual field defects associated with glaucoma and myopia: normal, enlarged blind spot (at least two abnormal edge points around blind spot), doubtful and glaucomatous visual field defect.
- A glaucomatous visual field defect was defined as (i) a Nasal step defect respecting horizontal meridian, (ii) an Early and advanced Arcuate defect extending from the blind spot, (iii) A paracentral defect 10-20 degrees from the blind spot located in Bjerrum's area (iv) Advanced glaucomatous field defect.

Perimetric defects crossing the horizontal meridian, generalised reduction sensitivity, rim artefacts, and central and cecocentral scotomas were doubtful. In addition, each subject had a short demonstration test before commencing the official examination. The subject's eye movements were monitored during the test, and adjustments were made to maintain proper fixation. Visual field testing was considered reliable only when the false negative responses were less than 33% and fixation loss was less than 20 % and were repeated immediately (up to two times) and any abnormal fields.

Statistical Analysis

Data were entered into the Excel spreadsheet, and variables were coded accordingly. The statistical analyses were performed using Graph pad Prism version 5 software. Data were presented as mean with Standard deviation for normal distribution/scale data (age and various time durations). Data were presented as the frequency with proportion n (%) for categorical data. Fisher's exact test was used to compare the frequencies between the groups. The unpaired 't' test was used to compare the means between the two groups. $P<0.05$ were considered statistically significant.

RESULTS

Among the 93 patients, 8 HM+PAC and 4 HM+PACS were excluded from the analysis. Hence, ultimately data from 81 patients were subjected to statistical analysis. Out of 93 HM patients, 54 (58.1%) were diagnosed as HM only, 27 (29%) were diagnosed as HM with PACG, 4 (4.3%) were diagnosed as HM with primary angle closure suspect, 8 (8.6%) were diagnosed as HM with primary angle closure.

Maximum patients 37 (45.7%) were observed in the age group of 40 to 50 years. 31.5% of patients with only HM were more than 50 years old. Whereas 44.4% of patients with HM + PACG were, more than 50 years and 27.8% of only patients were less than 40 years old. Female predominance was reported 47 (50.57%). 57.4% of females and 42.6% of males had HM only, while 59.3% of females and 40.7% of males had HM + PACG [Table 1].

The maximum number of patients (27.8%) were housewives in the HM-only group, whereas in

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HM+PACG, patients showed farmers (25.9%) were the maximum. The distribution of occupation between the two groups was statistically insignificant. The level of refraction in both eyes in HM-only patients was observed 1-2D in maximum patients (right: 68.5%; left: 64.8%), whereas in HM+PACG patients, it was observed at >2 – 3D in maximum patients (right: 55.6%; left: 55.6%). The effect was statistically significant ($p<0.05$) between both groups of patients in both eyes.

The axial length of >22 – 23 mm was observed maximum (85.2%) in patients of HM only, whereas, in HM+PACG patients, an axial length of >21 – 22 mm was observed in the majority of patients (48.1%). The effect was statistically significant ($p<0.05$) between both groups of patients in both eyes. On comparing ACD in both eyes, 74.1% of patients with HM only and 74.1% of HM + PACG patients had > 2 - 3 mm. No percentage of HM-only patients had 1-2mm, and no percentage of HM + PACG had > 3 -4 mm. The effect was statistically significant ($p<0.05$) between both groups of patients in both eyes [Table 2].

K1 value in both eyes and K 2 value of the right eye also showed significant ($p<0.05$) variation between patients having HM only and MH+PACG patients [Table 3].

On comparing gonioscopy findings in both eyes, all HM-only patients had an open angle, and all HM + PACG patients had grade I angle closure. The field defects in both eyes were absent in all HM-only patients, and it was present in all HM + PACG patients with significant effect ($p < 0.05$) [Table 4].

The NNR thinning in both eyes was absent in HM-only patients, whereas in HM+ PACG patients, it was 29.6% in the right eye and 51.9% in the left eye. The effect was statistically significant ($p<0.05$) between both groups of patients in both eyes. The cup and disk ratio of both eyes in HM-only patients was normal, whereas, in HM+PACG patients, it was >0.5 – 0.8 in 81.5% and 59.3% in the left eye and right eye, respectively [Table 4].

The mean IOP in the right eye was 16.07 mm Hg with a standard deviation of 2.5 mm Hg in HM-only patients and 25.3 mm Hg with a standard deviation of 3.3 mm Hg in HM + PACG patients. In the Left eye, the mean IOP was 15.7 mm Hg with a standard deviation of 2.2 mm Hg in HM-only patients and 25.3 mm Hg with a standard deviation of 3.03 mm Hg in HM + PACG patients. The effect was statistically significant ($p<0.05$) between both groups of patients in both eyes [Table 5, Figure 1].

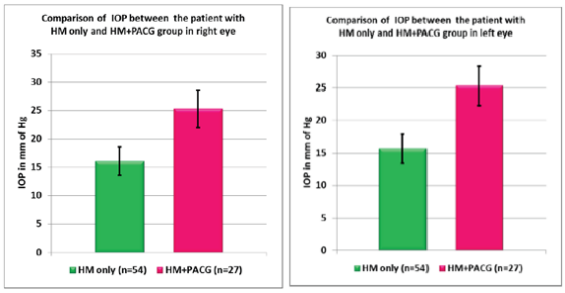

Figure 1: Comparison of IOP between patients with HM only and HM+PACG groups in (A) Right eye and (B) left eye

Table 1: Observation of demographic data of patients

Parameters	HM only (n=54) N (%)	HM + PACG (n=27) N (%)	p-value
Age group (years)			
<40	15 (27.8)	0 (0)	0.011
40 – 50	22 (40.7)	15 (55.6)	
>50	17 (31.5)	12 (44.4)	
Sex			
Female	31 (57.4)	16 (59.3)	0.999
Male	23 (42.6)	11 (40.7)	
Type of occupation			
Farmer	7 (13)	7 (25.9)	0.741
Driver	11 (20.4)	4 (14.8)	
Housewife	15 (27.8)	5 (18.5)	
Officer	5 (9.3)	3 (11.1)	
Others	4 (7.4)	2 (7.4)	
Tailor	12 (22.2)	6 (22.2)	

Table 2: Refraction, axial length, and depth of anterior chamber between groups

Parameters	HM only (n=54) N (%)	HM + PACG (n=27) N (%)	p-value
Refraction in the right eye			
<1D	12 (22.2)	0 (0)	<0.0001
1 – 2 D	37 (68.5)	7 (25.9)	
>2 – 3D	3 (5.6)	15 (55.6)	
>3 – 4D	2 (3.7)	3 (11.1)	
>4D	0 (0)	2 (7.4)	
Refraction in the left eye			
<1D	14 (25.9)	0 (0)	<0.0001
1 – 2 D	35 (64.8)	7 (25.9)	
>2 – 3D	3 (5.6)	15 (55.6)	
>3 – 4D	2 (3.7)	4 (14.8)	
>4D	0 (0)	1 (3.7)	
Axial length in both eyes			

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20mm	0 (0)	2 (7.4)	<0.0001
20 – 21 mm	0 (0)	1 (3.7)	
>21 – 22 mm	7 (13)	13 (48.1)	
>22 – 23 mm	46 (85.2)	11 (40.1)	
>23 mm	1 (1.9)	0 (0)	
Depth of anterior chamber of both eyes (ACD)			
1 – 2 mm	0 (0)	7 (25.9)	<0.0001
>2 – 3 mm	40 (74.1)	20 (74.1)	
>3 – 4 mm	14 (25.9)	0 (0)	

Table 3: K1 and K2 between groups

Parameters	HM only (n=54) N (%)	HM + PACG (n=27) N (%)	p-value
K1 in the right eye			
<42 D	9 (16.7)	3 (11.1)	0.033
42 – 44 D	35 (64.8)	24 (88.9)	
>44 D	10 (18.5)	0 (0)	
K1 in the left eye			
<42 D	9 (16.7)	3 (11.1)	0.039
42 – 44 D	32 (59.3)	23 (85.2)	
>44 D	13 (24.1)	1 (3.7)	
K2 in the right eye			
<42 D	5 (9.3)	2 (7.4)	0.043
42 – 44 D	35 (64.8)	24 (88.9)	
>44 D	14 (25.9)	1 (3.7)	
K2 in the right eye			
<42 D	4 (7.4)	3 (11.1)	0.051
42 – 44 D	36 (66.7)	23 (85.2)	
>44 D	14 (25.9)	1 (3.7)	

Table 4: Gonioscopy, field defects, NNR thinning, and cup-disc ratio between groups

Parameters	HM only (n=54) N (%)	HM + PACG (n=27) N (%)	p-value
Gonioscopy both eyes			
Grade I angle Closure	0 0	27 100	<0.0001
Open	54 100	0 0	
Field defects in left and right eyes			
Absent	54 (100)	0 (0)	<0.0001
Present	0 (0)	27 (100)	
NNR thinning in the right eye			
Absent	54 (100)	19 (70.4)	<0.0001
Present	0 (0)	8 (29.6)	
NNR thinning in the left eye			
Absent	54 (100)	13 (48.1)	<0.0001
Present	0 (0)	14 (51.9)	
The cup-disc ratio in the right eye			
Normal	54 (100)	0 (0)	<0.0001
0.3 – 0.5	0 (0)	11 (40.7)	
>0.5 – 0.8	0 (0)	16 (59.3)	
The cup-disc ratio in the left eye			
Normal	54 100	0 (0)	<0.0001
0.3 – 0.5	0 (0)	5 (18.5)	
>0.5 – 0.8	0 (0)	22 (81.5)	

Table 5: Observation of IOP in patients with HM and HM+PACG

Intra-ocular pressure (IOP)	HM only (n=54) mean± SD	HM + PACG (n=27) mean± SD	p-value
IOP RE (mm Hg)	16.07 2.5	25.3 3.3	<0.0001
IOP LE (mm Hg)	15.7 2.2	25.3 3.03	<0.0001

DISCUSSION

Patients in the age group of 30 years and above who attended the Out Patient Department of Ophthalmology (OPD), Thanjavur Medical College & Hospital, from December 2017 to May 2019, fulfilling the inclusion and exclusion criteria, were included in the study. This study aims to evaluate the characteristics of hypermetropia and identify the risk for angle closure glaucoma in hypermetropic patients. A major risk factor for developing PACG is increasing age. PACG is rare below 40 years of age. It peaked in the '50s and '60s among Caucasians and Eskimos. In this study, the mean age was 47.3 ± 8.5 years, 45.7% of patients were 40-50, and 50.6% were affected by PACG. This was against the study conducted by Hollows et al., where PACG peaked at 50-60 years of age.[11] In this study, 58% of patients were women, and this was similarly seen in a study by Yong et al.[12] Females are at increased risk for PACG over males by a ratio of 2.4:1 among Caucasians, as reported by Hallows et al. in their study.[11] The 59.3% of females were diagnosed to

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have PACG compared to males, 40.7% in our study. These are also similar to those of Dandona et al.[13]

Analysing the refractive status of HM + PACG patients in this study, 55.6% of patients were in between 2 to 3 D and 25.9% of patients were in between 1 to 2 D. It has been observed that PACG and narrow-angle more frequently occur in hypermetropia patient eyes.[14] Chennai Glaucoma study also reported the same as Hypermetropia with PACG patients. In this study, all HM + PACG patients were found to have grade I angle closed.[15] Similarity was also found in the Beijing study found a relation between Hypermetropia and Anterior Chamber angle, suggesting that for PACG predominant risk factor is Hypermetropia.[16]

In this study, we found that 27 patients with PACG had hypermetropia and grade I angle closure in gonioscopy with the shallow anterior chamber, implying that hypermetropic had a significant association with PACG as supported by Xu L et al.[16]

In this study, 48.1% of hypermetropia with PACG patients had the axial length of range between 21-22mm and 74.1% of HM + PACG patients had the Anterior Chamber depth of range between 2 to 3 mm. This is similarly seen in a study by Vijaya L et al.[15]

In our study, ACD of >2-3 mm was reported in maximum patients with HM (74.1%) and HM+PACG (74.1%). In comparison, ACD of 3-4mm was found in 25.9% of patients in the HM group and 0% in HM+PACG group patients. These findings in the present study follow earlier reported studies.[16] In our study, K1 in both eyes and K2 value in the right eye also showed significant ($p<0.05$) variation between patients having HM only and MH+PACG patients. La Rosa et al. also reported similar findings in their investigations.[17] In our study, comparing gonioscopy findings in both eyes, all HM-only patients had an open angle, and all HM + PACG patients had grade I angle closure. Dielemans et al. also reported open angles in HM-only patients in their investigations.[18]

In our study, the field defects in both eyes were absent in all HM-only patients, and it was present in all HM + PACG patients with significant effect ($p < 0.05$). Gazzard et al. showed that subjects in the PACG group exhibited more severe visual-field loss than the open-angle glaucoma group. The reason for the more severe field loss was unclear and may be due to the tendency of PACG patients to present later.[19] In our study, the NNR thinning in both eyes was absent in HM-only patients, whereas in HM+ PACG patients, it was 29.6% in the right eye and 51.9% in the left eye. Montgomery et al., in their investigation, also reported similar findings where NNR thinning was observed in PACG patients.[20]

In our study, the cup and disk ratio of both eyes in HM-only patients was normal, whereas, in HM+PACG patients, it was >0.5 – 0.8 in 81.5% and 59.3% of patients in the left eye and right eye, respectively. These findings in the present study follow earlier reported studies.[21] In the present study, a significant ($p<0.05$) difference was reported in IOP between HM-only patients and HM+PACG patients of both eyes. Gazzard et al. also reported higher mean IOP in patients with PACG.[22]

CONCLUSION

Although it is commonly believed that hypermetropia is a risk factor for PACG, in this study, we found that females 40-50 years of age group and with refractive status of the eye more than 2 D were more affected with Primary Angle Closure Glaucoma. Axial Length and Anterior Chamber Depth are equally important risk factors for developing Primary Angle Closure Glaucoma. We should check Intra Ocular Pressure and screen with gonioscopy in all patients with hypermetropia, and it should also be done for ACD by Ultrasound Biomicroscopy (UBM) and optic nerve head evaluation done by optical coherence tomography (OCT). These only reduce the incidence of PACG.

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