

RESEARCH ARTICLE

STUDY OF VISUAL FIELD IN HEALTHY
CHRONIC SMOKERS

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Background: Visual disturbances caused by smoking have been studied extensively though the pathogenesis is poorly understood. The significance to diagnose visual field disturbances because of smoking is that prognosis for return of vision is always good if the consumption of tobacco is restrained timely.

Aims & Objective: To study visual field in healthy smokers.

Materials and Methods: In this study, subjects from the outpatient clinic were selected randomly: 30 healthy smokers and 30 nonsmokers. These subjects were divided into two groups: test (smokers) and control (nonsmokers). Ocular examination of all the subjects was done including intraocular pressure measurement and fundus examination. Further, visual field analysis was carried out using an automated perimeter (M700; Medmont International). Then, interpretation of visual field was done along with assessment of visual field defects. Values obtained were analyzed using Z-test and unpaired Student's *t*-test. *p*-Value less than 0.05 was considered to be statistically significant.

Results: Average deviation (AD) and patterned deviation (PD) were found to be significantly high in smokers as compared to nonsmokers ($p < 0.001$). It was also observed that AD and PD were significantly high if the smoking load (average number of cigarettes multiplied by average duration of smoking) is more than 50,000 ($p < 0.005$ and $p < 0.02$, respectively). In smokers, retinal sensitivity was found to decrease and the presence of localized scotomas was observed, but the central vision was found to be preserved.

Conclusion: This study is important in diagnosing visual field defects in tobacco amblyopia to stop nicotine toxicity in time with early intervention, thereby preventing further damage to the optic nerve.

INTRODUCTION

The visual field is that portion of space in which objects are simultaneously visible to the steadily fixating eye. Any defect or abnormality of the visual field may reflect disease or damage to a specific portion of the visual pathway.^[1]

Certain studies have identified smoking as a major risk factor for blindness but early intervention and timely cessation of tobacco consumption can prevent blindness.^[2] Nicotine is a poison to the optic nerve, and automated perimetry is one of the important qualitative and quantitative tests that helps in early detection of tobacco-induced ocular damage.^[2,3]

In this study, evaluation was done for the effect of smoking on visual field (central 30°), screening of scotomas, and comparison of visual fields of smokers with those of nonsmokers using an automated perimeter (M700; Medmont International).^[4]

MATERIALS AND METHODS

This study was carried out in collaboration with the Department of Ophthalmology, Government Medical College, Surat, Gujarat, India. The study group comprised adult subjects attending the outpatient clinics on a volunteer basis. Pretest counseling followed by informed consent was obtained from all the subjects included in the study. The subjects were distributed in the age group 27–42 years; 30 smokers and 30 nonsmokers were selected randomly. All the subjects were men and were divided into test and control groups. Both the groups were comparable in every aspect except smoking. The subjects in the control group were nonsmokers whereas those belonging to the test group were smokers consuming 10–20 cigarettes per day for a variable period of 7–15 years.

Healthy chronic smokers and nonsmokers (for choosing healthy subjects, complete physical, systemic examination and laboratory investigations such as Hb, CBC, and RBS were carried out) with

small or no refractive error ($\pm 1D$) and normal visual acuity were included in the study. Subjects with large refractive error, those taking any type of local or systemic medication, those exposed to any type of toxic substances, and those having history of any eye or systemic disease were excluded from the study.

Complete ocular examination was done to rule out any local or systemic eye disease. Intraocular pressure was measured using the Schiøtz tonometer to rule out glaucoma. Fundus examination was also done with a direct ophthalmoscope to determine the lesions of the optic nerve, if any.

Following the standard full ophthalmologic examination, both eyes of all the subjects were tested by central 30-2 full threshold test for visual field analysis using the Medmont M700 automated perimeter with stimulus target projection by light-emitting diode. The study was carried out in a dark room; subject was made to sit comfortably 30 cm from the stimulus bowl. The chin was kept on chin rest, forehead touching the headrest; one eye was examined at a time while the other was occluded with occluder. The background illumination on bowl was 10 apostilb.^[4,5]

Following instructions were given to the patients:

- (1) To concentrate on the central fixation target that is yellow in color?
- (2) To respond to the flashes of variable intensity light on the bowl by clicking the trigger switch provided.

Visual field was interpreted using quantitative perimetric indices. Objective retinal sensitivity was measured in terms of dB values obtained from standard 30-2 full threshold test using mean average deviation (AD; i.e., difference between mean sensitivity obtained and that is expected) and patterned deviation (PD; i.e., regional nonuniformity of a visual field after adjusting for the mean defect of entire field).^[5] Visual field defects were also assessed with regard to the presence of scotomas.

Among the various automated perimeters available such as Humphrey and Octopus, Medmont M700 automated perimeter performs rapid and reliable screening and threshold tests of visual field, while providing comprehensive control over the test and detailed information on its progress.^[6,7]

RESULTS

All the subjects were men with an average age of 33.47 ± 4.42 years in the test group and 32.47 ± 4.71 years in the control group, that is, both groups had age-matched subjects.

Table 1: Comparison of height, weight, and BMI in smokers and nonsmokers

Subjects	Height (m) (mean \pm SD)	Weight (kg) (mean \pm SD)	BMI (kg/m ²) (mean \pm SD)
Smokers	1.56 \pm 0.03	56.16 \pm 3.62	23.18 \pm 1.32
Non-smokers	1.58 \pm 0.03	60.63 \pm 3.14	24.28 \pm 1.37

Table 2: Comparison of blood pressure, random blood sugar, and hemoglobin in smokers and nonsmokers

Subjects	BP (mm Hg) (mean \pm SD)	RBS (mg%) (mean \pm SD)	Hb (g%) (mean \pm SD)
Smokers	$\frac{116.31 \pm 11.60}{78.31 \pm 4.31}$	91.59 \pm 8.72	12.13 \pm 0.79
Nonsmokers	$\frac{116 \pm 9.35}{77.63 \pm 4.11}$	89.88 \pm 10.07	12.51 \pm 0.71

BP, blood pressure; RBS, random blood sugar; Hb, hemoglobin

Table 3: Comparison of average deviation in visual field between smokers and nonsmokers

Subjects	Mean (AD in dB)	SD	Z-test	p-Value
Non-smokers	10.83	1.56	13.00	<0.001
Smokers	15.64	1.39		

AD, average deviation

Table 4: Comparison of patterned deviation in visual field between smokers and nonsmokers

Subjects	Mean (PD in dB)	SD	Z-test	p-Value
Nonsmokers	7.95	1.65	11.59	<0.001
Smokers	12.53	1.53		

PD, patterned deviation

Table 5: Comparison of average deviation in visual field according to smoking load

Smoking load	Number of subjects	AD (dB) Mean \pm SD	p-Value
<50,000	20	15.09 \pm 0.92	<0.005
>50,000	10	16.56 \pm 1.58	

AD, average deviation

Table 6: Comparison of patterned deviation in visual field according to smoking load

Smoking load	Number of subjects	PD (dB) Mean \pm SD	p-Value
<50,000	20	11.99 \pm 0.76	<0.02
>50,000	10	13.44 \pm 2.04	

PD, patterned deviation

Tables 1 and 2 show no statistical difference in test and control groups by comparing their vital parameters, that is, height, weight, body mass index (BMI), mean blood pressure, and mean random blood sugar (RBS). Tables 3 and 4 show the comparison of AD and PD in the visual field between smokers and nonsmokers for which Z-test was used. The mean of AD in nonsmokers was found to be 10.83 ± 1.56 and in smokers it was found to be 15.64 ± 1.39 , which was significantly higher ($p < 0.001$). The mean of PD in nonsmokers was 7.95 ± 1.65 and that in smokers was 12.53 ± 1.53 , which was also

significantly higher than that of the control group ($p < 0.001$).

Tables 5 and 6 show the values according to smoking load (average number of cigarettes per day multiplied by number of days).^[8] Values of AD and PD in smokers with smoking load $<50,000$ were 15.09 ± 0.92 and 11.99 ± 0.76 , respectively, whereas those in smokers with smoking load $>50,000$ were 16.65 ± 1.58 and 11.34 ± 2.04 , respectively. Unpaired *t*-test was used and the values were found to be significantly higher in smokers with more smoking load ($p < 0.005$ and $p < 0.02$ for AD and PD, respectively). Localized cecocentral scotomas typical of optic neuropathy due to tobacco amblyopia were detected in all the subjects whereas their central vision was preserved. These scotomas involved the region between fixation and blind spot.^[9]

DISCUSSION

Visual field examination is a threshold measurement of various regions of retina. It is not possible to examine every point in the entire field of vision. So in practice, a limited number of areas are selected for testing visual field. The minimum light stimulus is measured while testing these selected points, which is required to produce a response by the patient. Threshold stimulus can take place in total darkness or against a background of measured luminance. In the latter case, one is measuring the minimum contrast between stimulus and background.

Certain studies done on visual field defects due to glaucoma, smoking, drug abuse, and nutritional deficiencies have shown that heavy smokers of tobacco almost invariably show some defect in the color fields, especially in red and green. A central area in the field of vision will be blind to these two colors.^[10] Nicotine in tobacco is like a poison to the optic nerve. Its continuous use for a prolonged period damages the optic nerve. This damage is not complete but it reduces the efficiency of eye by paralyzing the nerves of sight in such a way as to reduce the visual field.^[11]

Our study showed that healthy chronic cigarette smokers had a decreased retinal sensitivity proved by the global perimetric indices, associated with localized scotoma, preserving central vision. Visual field defects are characterized by soft margins difficult to define for white stimuli but larger and

easier to plot for colored targets.

In this study, significant increase in AD can be explained as a diffused decrease of retinal sensitivity in cigarette smokers compared to controls. PD indicating localized field defects was also found to be increased significantly in smokers, which were actually consistent with scotomas between 20° and 30° . Hence by detecting scotomas in smokers, early intervention can be done and further damage to the optic nerve can be prevented by stopping tobacco consumption.

Few studies have shown that administration of non-cyanide-containing vitamin B₁₂ produced a rapid improvement in visual acuity even in those patients who continued smoking.^[12] There is evidence that in tobacco amblyopia primary lesion is a degeneration of the ganglion cell layer of retina with secondary atrophy of nerve fiber layer of retina and the papillomacular bundle of the optic nerve.^[12,13]

Apparently, tobacco amblyopia is due to disturbance in the distribution of thiocyanate in body fluids; it is in fact a form of cyanide poisoning as confirmed by its response to treatment with intramuscular hydroxycobalamin even with continued consumption of tobacco.^[14]

A major limitation of this study is that it is time-consuming. However, further detailed studies such as contrast sensitivity, pattern visual evoked potential, and pattern ERG are required to evaluate and distinguish early retinal and/or optic nerve dysfunction.

CONCLUSION

In this study, AD and PD were found to be significantly higher in the test group indicating localized field defects. These findings appear to further substantiate the chronic nicotine toxicity by its direct neurotoxin effect on the optic nerve and/or vascular effect seems to be associated with decreased retinal sensitivity in smokers.

Hence, it was concluded that nicotine consumption causes significant damage to the optic nerve, enough to cause blindness. This study also suggests a possible role of quantitative perimetric indices in early detection of tobacco-induced ocular damage and thereby helps in preventing further damage to the optic nerve.

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