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A Cross-Sectional Study On Prevalence Of Congenital Colour Blindness In 500 Students Aged 16-25 Years Examined At IMCH, Tiruvallur

S. Srinivasan, B. Sireesha, R. Jebin David
(Ophthalmology, Indira Medical College And Hospital, India)
(Ophthalmology, Indira Medical College And Hospital, India)
(Ophthalmology, Indira Medical College And Hospital, India)

Abstract:
Background*: Colour blindness is inherited by X linked recessive manner. Partial colour blindness is more common. Red-green colour blindness is more common followed by blue-yellow colour blindness.*
Materials and Methods*: Medical students coming for routine eye check-up, students examined during medical camp, paramedical staff including nursing students coming for routine eye check-up during the period of January 2024 to November 2024 were included in the study. Routine eye examination was carried out in all cases including slit lamp examination, visual acuity by Snellen's chart, Colour vision by Ishihara colour vision chart, direct and indirect ophthalmoscopic examination.*
Results*: In our study, we detected four male students and one female student suffering from defective colour vision. In male gender, out of 4 persons, 3 were suffering from partial colour blindness and 1 from total colour blindness with normal visual acuity, whereas only one female was detected to be suffering from total colour blindness. All the partial colour blindness cases were having defects in appreciation of red and green colours, and they are inherited. Percentage of colour blindness in our case study is 1%.*
Conclusion: *As per our study, 60% of the colour vision deficiency cases were partial in nature, and 40% were total in nature. All the students with partial colour blindness were having Red-green colour blindness. Male students were affected more commonly than female students due to X linked recessive inheritance.*
Key Word: *Colour Vision Deficiency, Red-Green Colour blindness, Ishihara Colour Vision Chart, Partial Colour Blindness, Total Colour Blindness.*

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I. Introduction

Colour vision is mediated by three types of cone photoreceptor – designated short (S), middle (M), and long (L) wavelength sensitive. Loss of function of each cone photoreceptor is associated with an inherited form of colour vision deficiency. Protan defects are associated with loss of L cone function, deutan defects with loss of M cone function, and tritan defects with loss of S cone function.

Red-green colour vision defects are caused by rearrangement and deletions of the L and M opsin genes on the X chromosome during meiotic recombination. If meitoic recombination creates two genes which encode pigments with identical spectral properties, the male will be dichromatic, either protanopic or deuteranopic. However, if meitoic recombination creates two genes which encode opsins of the same class (M or L), but differ slightly in spectral sensitivity, the male will be an anomalous trichromat. If the genes encode two M opsins, the male will be protanomalous. If they encode two L opsins, he will be deuteranomalous.

Blue-yellow, or tritan, defects are caused by mutations in the S opsin gene, and are inherited in an autosomal dominant fashion. So an individual heterozygous for S opsin gene mutation will often exhibit the phenotype.

Visual pigments are made of an apoprotein and an 11-cis retinal chromophore. The genes, OPN1LW, OPN1MW, and OPN1SW, encode for the apoprotein (known as opsin).[1] The chromophore absorbs the ultraviolet light; when the chromophore is covalently bound to an opsin, the absorption spectrum will be shifted to longer wavelengths. The opsins have amino acid differences which are responsible for the differences in the absorption spectrum of the three cone classes.

OPN1MW encodes for middle-wavelength sensitive opsin, expressed in M cones, also known as 'green' cones. OPN1MW is located at Xq28 on the X-chromosome. Deutan defects are associated with the absence of this OPN1MW gene.

OPN1LW encode for long-wavelength sensitive opsin, expressed in L cones, also known as 'red' cones. OPN1LW is located at Xq28 on the X-chromosome. Protan defects are associated with the absence of this OPN1LW gene.

OPN1SW encode for short-wavelength sensitive opsin, expressed in S cones, also known as 'blue' cones. OPN1SW is located on chromosome 7 at 7q32.1. Tritan defects are associated with missense mutation in one copy of this OPN1SW gene. A missense mutation is the change in amino acid sequence of a gene that substitutes one amino acid for another.

Tests of colour vision:

Ishihara's test of colour vision and the Hardy, Rand, and Rittler (HRR) pseudoisochromatic plates are the most frequently used tools for diagnosing colour vision deficiencies.The plates contain dots of various colours and shades of gray, each containing a symbol that is visible to people with normal colour vision. Patients are asked to identify the symbols, and the specific pattern of errors on the plates allows for diagnosis of a colour vision defect, and help in identifying the type and severity.

Other tests include arrangement tests, in which patients are asked to arrange coloured discs in series so that each disc is placed adjacent to the disc that is most similar in colour when compared to the previous one. Commonly used arrangement tests are the Farnsworth Munsell 100 Hue Test and its abridged version, the Farnsworth Munsell Dichotomous D15 Test.

Rayleigh colour match is the 'gold standard' for colour vision testing. It is performed with an anomaloscope which contains an optical system that produces two side by side lighted fields. The 'test light' on one field is monochromatic amber colour, and the other field is a mixture of red and green light. The patient is asked to adjust the ratio of red and green light in the mixture until it matches the amber test light. The ratio of red and green light is compared to the ratio in the match made by a person with normal colour vision. This test is very sensitive and can detect minute alterations in the spectral sensitivities of the photopigments.

II. Material And Methods

All the students were tested for colour vision using Ishihara colour vision chart. Medical students coming for routine eye check-up, students examined during medical camp, paramedical staff including nursing students coming for routine eye check-up were included in the study. Routine eye examination was carried out in all cases which includes slit lamp examination, visual acuity by Snellen's chart, direct and indirect ophthalmoscopic examination.

Study Design: Cross sectional study.

Study Location: This was a tertiary care teaching hospital-based study done in Department of Ophthalmology, at Indira Medical College and Hospital, Tiruvallur, Tamil Nadu.

Study Duration: January 2024 to November 2024.

Sample size: 500 students aged 16-25.

Inclusion criteria:

Medical, paramedical and nursing students coming for routine checkup; students examined during medical camp. The age group of individuals was between 16 to 25 years.

Exclusion criteria:

Macular lesions, injury to the eye, drugs like chloroquine induced conditions and sickle cell anaemia were excluded from the study.

III. Results

500 cases were screened in our study. 323 were female and 177 were male. Out of 500 cases, 3 patients had partial colour blindness and 2 patients had total colour blindness. All the 3 patients with partial colour blindness were male students. Out of the 2 patients with total colour blindness, one was male and one was female. All the 3 patients with partial colour blindness have deuteranomaly. In this study, the percentage of colour blindness is 1%. All the 5 students were having colour blindness in both eyes. All the 5 students were having congenital colour blindness. All the 5 students underwent B scan and OCT macula which were found to be normal in all 5 students. There was no family history of colour blindness in any of them.

Table no 1: Sex distribution.

Total number of cases in study	Male	Female
500	177	323

Image 1: Sex distribution

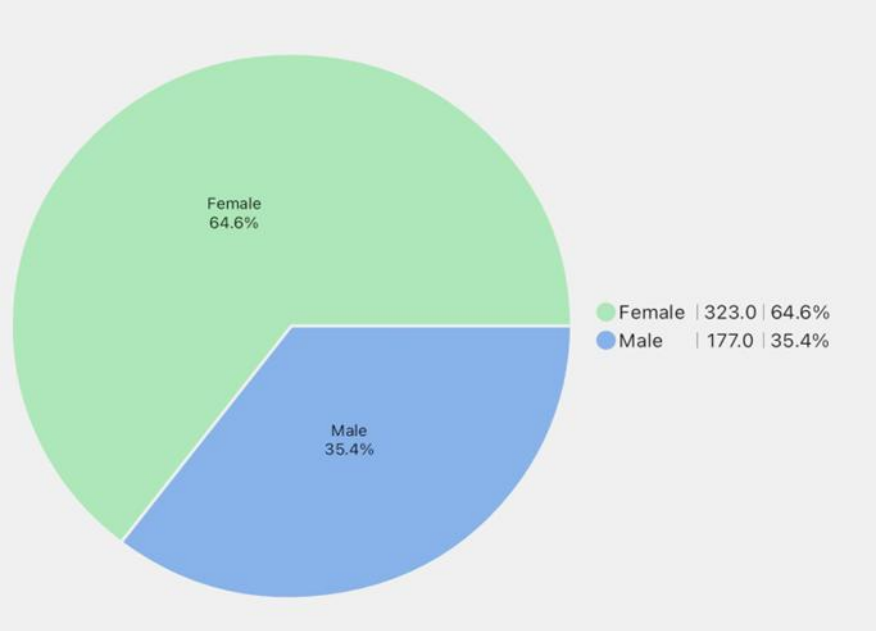

Table no 2: Prevalence of colour blindness with respect to Gender.

Gender	Normal colour vision	Partial colour blindness	Total colour blindness
Male	173	3	1
Female	322	0	1

Table no 3: Distribution of type of colour vision defect among the cases.

Distribution type	Number of patients
Normal colour vision	495
Protanopia	0
Protanomaly	0
Deuteranopia	0
Deuteranomaly	3
Tritanopia	0
Total colour blindness	2

Table no 4: Age distribution of colour vision defect among the cases.

Age	Partial colour blindness	Total colour blindness
16-20	0	1 (Female)
21-25	3 (Male)	1 (Male)

Table no 5: Laterality of colour blindness in the detected cases.

Unilateral	Bilateral
Nil	5

Table no 6: Family history in the detected cases.

Total number of cases of colour blindness	Family history present	Family history absent
5	Nil	5

IV. Discussion

In India the incidence of colour blindness is 0.5% in females and 5-8% in male. In the current study there is an increased prevalence of defective colour vision in male population compared to females. Out of 500 students screened during regular eye check up, 5 students were having defective colour vision. Hence the percentage of colour blindness in the current study is 1%. Out of these 5 students, there were 4 male students and one female student. Hence out of 177 male students in the current study, 4 were having colour blindness; therefore the prevalence of colour blindness among male students is 2.25%. Out of 323 female students in the current study, only one was having colour blindness. Therefore, the prevalence of colour blindness among female students in the current study is 0.3%. Out of these 5 students, 4 students were in the age group of 21-25 years; one student was in the age group of 16-20 years. Out of the 5 students, 3 were having partial colour blindness and 2 were having total colour blindness. All the 3 students with partial colour blindness were having deuteranomaly. In the current study predominantly congenital, inherited cases of colour blindness either partial or total were detected.

The term colour blindness was introduced by David Brewster, previously known as daltonism.[2] Most of the patients with colour blindness are undetected due to absence of proper screening.

In a study conducted by Gao JG et al, 17303 students underwent physical examination.[3] Out of the 17303 students examined, 381 were having colour vision defects of which 368 were male and 13 were female. Hence the prevalence of colour vision defects among male students was 4.11% and among the female students was 0.16%. The prevalence of colour vision defects among the male students was significantly higher than the female students.

In a study conducted by Al-Aqtum MT et al, 1418 students from Zarka Private University and Hashemite University underwent colour vision testing using Ishihara pseudo-isochromatic colour plates.[4] The prevalence of colour blindness was found to be 0.33% among female students and 8.72% among male students.

In a study conducted by Jha RK et al, 825 undergraduate students aged 17-25 years in Kathmandu University, Nepal were tested for colour vision using Ishihara plates.[5] 24 students were found to be colour blind and all the 24 were male students.

In a study conducted by Niroula DR et al, the school children of Pokhara city in western Nepal were examined for colour vision.[6] 964 children including 474 boys and 490 girls were taken for the study. The age group of children was between 10 to 19 years. 18 boys were found to be colour blind. None of the girls were colour blind. The prevalence of colour blindness among boys was 3.8%.

V. Conclusion

The current study shows slightly lesser prevalence of colour blindness. This could be due to the age group selected for the study. This implies that the study population must have included school children also to get accurate prevalence of colour blindness in Tiruvallur district. Screening for colour blindness among school children will help in early diagnosis and early management. EnChroma glasses are useful for partial colour blindness especially red-green colour blindness. The success of gene therapy in humans for colour blindness management is not far away.

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