ORIGINAL ARTICLE

COLOUR VISION DEFICIENCY (CVD) IN MEDICAL STUDENTS

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Background: The incidence of Colour vision deficiency varies from race to race and different in different geographical areas. Colour is very important sign used in medical profession, but there is no effective screening for Colour Vision Deficiency (CVD) at any level of medical profession. With the introduction of OSPE / OSCE in university examinations in Pakistan at undergraduate and postgraduate levels, the students with CVD may feel difficulty in identifying colour slides, lab instruments, specimens and examining patients leading to failure in the examination so this study is aimed to find out the incidence of CVD in medical students. **Methods:** A total of 2,000 medical students including 750 males and 1,250 females between ages 18–21 years were examined for CVD in different Medical colleges of Faisalabad. Each student of 1st year MBBS class without occular abnormality was shown the complete range of Ishihara's plates under day light conditions at normal reading distance. **Results:** Participant's colour vision was tested using Ishihara's Charts (Plates). Among 750 boys, 18 were colour deficient (2.4 %). Among 1250 girls, 56 were colour deficient (4.48 %). These results are discussed in relation to other studies and data on colour vision. **Conclusion:** With this incidence of colour vision deficiency, the students with CVD may feel difficulty in identifying colour slides, lab instruments, specimens and examining patients leading to failure in examination and difficulty in medical practice.

Keywords: Ishihara's Charts (Plates), Colour vision deficiency, Colour blindness.

INTRODUCTION

Colour vision plays an important role in health care system. Colours have three attributes: hue, intensity and saturation[1]. Colour blind people are not actually blind, but are colour deficient, so more appropriate term to be used for colour blindness is colour vision deficiency (CVD). The first known scientific paper on CVD was written by John Dalton, who himself was colour blind, so CVD is also called 'Daltonism', after John Dalton.[2] CVD is a condition characterized by disturbances of colour perception that occur if the amount of visual pigment per cone is reduced, or if one or more of the three cone systems are absent.[3] Individuals with CVD are often unable to distinguish between different colours of the spectrum.

Wide spread interest in CVD followed John Dalton's description of his own Duetan (middle wave) deficiency[4], but, for the preceding centuries, the deficiency has been described as an immensely well kept secret.[5] Many doctors may be unfamiliar with some modern concepts of colour vision; however, excellent reviews can be found.[6–9] The Young Helmholtz theory of colour vision in humans postulates the existence of three kinds of cones, each containing a different photopigment and that are maximally sensitive to one of the three primary colours. Red, green and blue are the basic colours. Colour is mediated by ganglion cells that subtract or add input from one type of cone to input from another type.[1] Normal vision is trichromatic, the three primary hues are detected by three types of cones containing photosensitive pigments that overlap but peak in the green (long wavelength), yellow-green (middle wave length), and violet (short wave length) parts of the spectrum. By comparing the rates of absorption of photons, the visual system is able to discriminate colours. It is the varieties of hue, saturation (the similarity of a colour to white) and brightness that lead to an estimate that the human eye is able to distinguish, at equal luminance 17,000 perceptible differences in colour.[10] When a specific colour receptive cone is missing from the eye, the person is unable to distinguish same colour from others. Adjoining colours (colour contrast and colour constancy), expectation[11], and memory[12] are among factors that influence the colours actually perceived.

The four types of CVD are Protan (red or long wave), Duetan (green or middle wave), Tritan (blue or short wave), and Achromatopsia (total absence of colour vision).[13] Aetiologically, colour vision defect may be congenital (CCVD) or acquired (ACVD).[14] Congenital CVD has 8% prevalence for men and 0.4% for women in general population.[14] Red-green perceptive disorders are X-linked[15] recessive, but blue colour perceptive disturbance is caused by a simple mutation in gene coding for blue receptor on chromosome 7, and is autosomal dominant[16]. The acquired deficiencies are caused by ocular and intracranial pathologies[14], drugs[17], diabetic retinopathy, hypertension, glaucoma, macular degeneration and yellowing of the lens[18] due to ageing. Tritan deficiencies are the most common of acquired form.[14] The prevalence of acquired deficiencies is not known but probably greater than the congenital form, particularly in older people.[19]

Association between hearing and vision impairment has been investigated in detail. The findings

have significance for clinicians, in that finding a deficit in one domain (vision) indicates an increased likelihood of deficit in the other domain (hearing) especially in old age.[20]

In a study[21], it was concluded that doctors suffering from CVD were poorer detecting physical signs and naming the colours and were less confident about their decisions. So the patients' safety is potentially jeopardised if CVD is not tested both initially and routinely.[22] Health professionals suffering from CVD have difficulty detecting body colour changes (pallor, cyanosis, jaundice), skin rashes and erythema, Stage I pressure ulcers, blood or bile in urine, faeces, sputum, vomit, malaena, mouth and throat conditions, test strips, colour coded medications, charts, slides, prints, and colour sensitive monitors etc.[23,24]

Colour is very important sign used in medical profession, but there have been few studies with references to implications of colour vision deficiency (CVD) on the medical skills of the persons involved in medical profession.[14] Medical students are screened for congenital colour vision deficiency at only one university in United Kingdom[25,26] and at a few in rest of the world[14]. Prevalence of (CVD) varies from race to race, and is different in different geographical areas.

With the introduction of OSPE/OSCE in university examinations, the students with CVD may feel difficulty in identifying colour slides, lab instruments, specimens, and examining patients, leading to failure in the examination. This study is aimed to find out the incidence of CVD in medical students.

MATERIAL AND METHODS

A total of 2,000 medical students of 1st year MBBS class including 750 boys and 1,250 girls aged 18–21 years have been tested for CVD in Punjab Medical College Faisalabad, Independent Medical College, Faisalabad, and University Medical and Dental College, Faisalabad. The inclusion criteria were 1st year MBBS class without occular abnormality.

Each student was shown the complete range of Ishihara's plates under day light conditions at normal reading distance. Time consumed for reading each plate was not more than 5 seconds. The plates were shown to each student once only.

RESULTS

Total 2,000 students of age group 18–21 years were examined having mean age 20.85 years. The frequency of CVD in the subjects is shown in Table-1.

Table-1: Frequency of CVD in first year medical students (n=74)

Subject (n=2000)	No.	%
Male (n=750)	18	2.4
Females (n=1250)	56	4.48

DISCUSSION

The prevalence of CVD varies from race to race and differs in different geographical area.[25,26] Vijayalakshmi *et al*, reported CVD in Hindu casts and religious groups of different parts of the India. The prevalence reported was 2.1% in 7,542 males and 0.2% in 3,519 females.[27] Prevalence of the CVD in Caucasians is 8% for men and 0.4% for women.[28] In Western Nepal, in a study on 964 school children (10–19 years age group), CVD was found in 18 boys with prevalence of 3.8%, but none of the girls was found affected.[25] Sardighan[29] reported 2.13% and 0.57% CVD in male and female Iranian medical students respectively. In USA, prevalence of CVD in junior medical students was 12.8%[30], and in dental students it was 7.8%[31]. In UK, prevalence among histology students was 8.7%.[32] Seven percent of males and 0.4% of female population is suffering from CVD in 10 million American people.[33] In the present study, the observation among medical students of Faisalabad revealed prevalence of 2.4% in males and 4.48% in females. Significantly higher prevalence in females requires further work to explore the problem.

Individuals with CVD perform less well than those with normal colour vision.[14] Failure of observation for those with congenital CVD has been demonstrated for students in practical chemistry[31], histopathology[32], microscopy[34], and persons using colourimetric test for blood and urine samples[35,36,37]. Koningsberger *et al*[38] found 15 (11.11%) endoscopists with CVD attending a meeting, all of them were unaware of it. The direct observation of physical signs in patients that are reported to cause difficulties, for example, pallor, erythema, cyanosis, and body products, comprise the range of colours that are known to cause failures of discrimination for those with CVD.[14,30,39] CVD becomes very important in cases where there is so called pivotal observation[40], a single sign that is essential to observe for the correct course of action. If a doctor misses certain symptoms or clues because of CVD, the patient's medical issue may be undetected and become worse when it could easily have been prevented. With the increased use of colour oriented computer screens, people with CVD may likely miss important signs that indicate cancer or other anomalies that are present. Spalding[23] found support that doctors and nurses with CVD, specifically moderate or severe performed worse than ones with normal colour vision for certain medical procedures.

As for outlook/prognosis is concerned, it is still a lifelong condition and there is no known treatment[41], but experimental study on adult red green colour blind primates (gene therapy cures colour blind monkeys[42]) might provide a breakthrough in this regards. Recolouring tools are available that modify the colours in an image so they are more easily distinguishable for those with CVD.[43]

CONCLUSION AND SUGGESTIONS

With higher incidence of colour vision deficiency, the students with CVD may feel difficulty in identifying colour slides, specimens, and examining patients leading to failure in examination, and difficulty in medical practice. There is need for screening for CVD in medical students, medical laboratory technologist and doctors, not only at the time of selection, but also periodically during training/practice. This would facilitate the detection and management of CCVD as well ACVD more effectively.

REFERENCES

1. Barrett KE, Barman SM, Boitano S, Brooks HL. Vision. In: Ganong's Review of Medical Physiology. 23rd ed. New Dehli: Tata McGraw Hill Education Private limited; 2010. p.195–7.
2. Dalton J. Extraordinary facts relating to the vision of colors: with observations. Memoirs of the Literary and Philosophical Society of Manchester 1798;5:28–45.
3. Colors for color blind. (Clinical information) 2011; Available at: http://www.teledo-bend.com/color blind/cbinfo.asp.
4. Mollon D, Kanwaljit S, Hunt D, Hunt DM. Dalton's colour blindness: an essay in molecular biography. In: Dickinson C, Murray I, Carden D, (Eds). John Dalton's colour vision legacy. Selected proceedings of the International Conference, Bristol 1995.
5. Bradley N. Color blindness: notes on its development and clinical significance. Int J Psychol 1970;51:59–70.
6. Mollon JD. Color vision. Ann Rev Psychol 1982;33:41–85.
7. Wandell BA. The foundations of vision. Sunderland: Sinauer Associates (1995). xvi.476 pp.
8. Hubel DH. Eye, brain and vision. Scientific American Library Series, No. 22. New York, NY, US: Scientific American Library/Scientific American Books;(1995). viii 242 pp.
9. Birch J. The diagnosis of defective colour vision. Oxford: Oxford University Press; 1993.
10. MacAdam DL. Visual sensitivities to color differences in day light. J Opt Soc Am 1942;32:247–74.
11. Bruner JS, Pistman L, Rodrighes J. Expectations and the perception of color. Am J Psych 1951;64:216–27.
12. Duncker K. The influence of past experience on perceptual properties. Am J Psychol 1939;52:255–65.
13. Color Blindness: Genetics. Available at http://www.buzzle.com/articles/colour-blindness-genetics.html.
14. Spalding JAB. Color vision deficiency in medical profession. Br J Gen Prac 1999;49(443):469–75.
15. Nathans J, Piantanida TP, Eddy RL, Shows TB, Hogness DS. Molecular Denetics of Inherited Variation in Human Color Vision. Science 1986;232:203–10.
16. Color blindness: More prevalent among males. Available at: http://www.hhmi.org/sewes/b130.htm.
17. Ruddock KH. Acquired deficiencies of human color vision. Bailliere's Clinical Neurology. London: Bailliere Tindall;1993.
18. Lakowski R. Is deterioration of color discrimination with age due to lens or retinal changes? Die Fabre 1962;11:69–86.
19. Francois J, Verriest G. Nouvelle observations de deficiencies acquises de la discrimination chromatique. Annales D'Oculistique 1968;201:1097–114.
20. Schneck ME, Lott LA, Haegerstrom-Portnoy G, Brabyn JA. Association between hearing and vision impairments in older adults. Ophthalmic Physiol Opt 2012;32(1):45–52.
21. Campbell JL, Spalding JAB, Mir FA. The description of physical signs of illness in photographs by physicians with abnormal colour vision. Clinical and Experimental Optometry 2004;87(4–5):334–8.
22. Cole, Barry L. Assessment of inherited colour vision defects in clinical practice. Clinical and Experimental Optometry 2007;90(3):157–75.
23. Spalding JAB. Colour vision deficiency in medical profession. Br J Gen Pract 1999;49:469–75.
24. Cole BL. The handicap of abnormal color vision. Clinical and Experimental Optometry 2004;87(4–5):258–75.
25. Niroula, Saba. The incidence of colour blindness among some school children of Pokhara, West Nepal. Nepal Med Coll J 2010;12(1):48–50.
26. Poole CJM, Hill DJ, Christie JL, Birch J. Defective colour vision and interpretation of histopathology slides: cross sectional study Br Med J 1997;315:1279–81.
27. Vijyalakshmi M, Naidu JM, Suryanar. Blood group ABH Saliva secretions and colour vision deficiency in Hindu casts and religious group of West Godavari, Andhra Pardesh India. Anthropol Anz;1994;52(4):305–13.
28. Spalding JAB. Medical students and congenital color vision deficiency; unnoticed problems and the case for screening. Occup Med 1999;49:247–52.
29. Sadighan M. Colour blindness among medical students. Pakistan J Med Res 1974;13(4):91–2.
30. Logan JS. The disability in so called red green blindness. An account based on many years of self observation. Ulster Med J 1977;46:41–5.
31. Davison SP, Mysilinski NR. Shade selection by color vision defective dental personnel. J Prosth Dent 1990;63:97–101.
32. Olson IA. The use of colour filters by students with congenital color defects in the learning of histology. Med Biol Illus 1971;21(1):52–3.
33. Color blindness; more prevalent among males. Available at: http://www.hhmi.org/sences/b130.html.
34. Tocantins LM, Jones JW. Defective color vision and its handicaps in medicine. Am J Sci 1993;293:243–9.
35. Iinuma, Handa Y. A consideration of racial incidence of congenital dyschromats in males and females. Med Probl Ophthal 1976;17:151–7.
36. Aspinal PA, Hill AR, Cameron D. An evaluation of the Ames Clinitest. In: Verriest G (Ed). Colour vision deficiency V. Proceedings of the International Research Group on Colour Vision Deficiencies 1979. Bristol: Adam Hilger, 1980.
37. Allwood MC, Tyler R. Color vision and blood glucose self monitoring in diabetics. Pract Diabetes Int 1988;5(3):110–2.
38. Koningsberger JC, ban Norden D, van Niel JCG, Dekker W. Does color vision deficiency in the endoscopists influence the accuracy of endoscopic diagnosis? An anonymous study with Dutch gastrointestinal endoscopists. Endoscopy 1994;26:549–53.
39. Spalding JAB. Doctors with inherited color vision deficiency: their difficulties in clinical work. In: Cavonius CR (Ed). Color vision deficiencies XII. Dordrecht, Kluwer Academic 1997;20:483–9.
40. Bradley JW. Disease Diagnosis and Decision. Chichester, UK: Jon Wiley and Sons;1986.p.49–69.
41. Color blindness: Medline Plus Medical Encyclopedia. Available at: http://www.nlm.nih.gov/medlinePlus/ency/article/001002.html
42. Mancuso K, Hauswirth WW, Li Q, Connor TB, Kuchenbecker JA, Mauck MC, *et al*. Gene therapy for red-green color blindness in adult primates. Nature 2009;461(7265):784–7.
43. Flatla DR. Accessibility for individuals with color vision deficiency. ACM SIGACCESS Accessibility and computing: 2012;102:8–12.

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