

## Original Article

# COLOR VISION DEFECT IN PHAKIC VERSUS PSEUDOPHAKIC EYE GROUP

Muhammad Asif<sup>1</sup>, Mehak Nazir<sup>2</sup>

<sup>1</sup>Department of Ophthalmology and Visual Science, Dow University of Health Science, Karachi, Pakistan

<sup>2</sup>Isra School of Optometry, Al-Ibrahim eye hospital, Karachi, Pakistan

Correspondence:

Muhammad Asif  
Department of  
Ophthalmology and  
Visual Science, Dow  
University of Health  
Science, Karachi,  
Sindh, Pakistan  
Email:  
[muhammadasif.9199@duhs.edu.pk](mailto:muhammadasif.9199@duhs.edu.pk)

**ABSTRACT:**

This study was aimed to determine the color vision defect in pseudophakic and phakic groups. This was a cross-sectional study with non-probability convenience sampling. The patients' age ranged between 45 and 60 years, and they had a follow-up after one month of surgery. The visual acuity recorded ranged from 6/6 to 6/18 after refraction. All types of refractive errors after phacoemulsification surgery (acrylic IOL) were included. Posterior subcapsular opacity and other types of cataract surgery were excluded. The Panel D-15 test was used to assess color vision defects. Ethical approval was obtained from the institutional Research Ethical Committee (REC). Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) version 20.0. A total of 160 eyes were enrolled in this study. Among these, 70 (44%) and 90 (56%) eyes belonged to males and females, respectively. The eyes were categorized into two groups: 80 (50%) were phakic and 80 (50%) were pseudophakic. Among the 80 pseudophakic eyes, 32 eyes had tritanopia (40%), 10 eyes had deuteranopia (13%), 8 eyes had protanopia (10%), 6 eyes had combined tritanopia and protanopia (8%), 4 eyes had combined deuteranopia and tritanopia (5%), 2 eyes had protanopia and deuteranopia (3%), and 18 (23%) had no defect. Among the 80 phakic eyes, 72 (90%) had no defect, while deuteranopia was found in 1 (1.25%) eye and tritanopia in 7 (9%) eyes. Tritanopia was most commonly observed in the pseudophakic group, while the majority of the phakic group did not show any color vision defect.

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## INTRODUCTION

Color vision is a feature of perception that is the ability to perceive differences between lights composed of different wavelengths, independently of light intensity. There are three kinds of color-vision genes in humans: a "blue" pigment gene on chromosome 7, and "red" and "green" pigment genes located at the tip of the long arm of the X chromosome-Xq28 (1). The corresponding pigments are located in three different classes of retinal cone cells, each containing a different photo pigment. These pigments have characteristic maximal absorption spectra: 420 nm or shortwave (blue), 530 nm or middle wave (green), and 560 nm or long wave (red) (2). Color vision perception can be classified into three types based on wavelength sensitivity: Monochromats, Dichromats, and Anomalous Trichromats.

*Mechanism of color vision:* The eye forms images based on differences in the reflectance of light from external objects. Small perturbations, in contrast, are processed through a center-surround system, where surrounding background luminance is subtracted from the center signal, highlighting the local features of the central signal (3). This system provides high sensitivity to light-dark contrast (4).

Color vision deficiencies diminish the capacity to distinguish certain colors under specific circumstances and its testing identify the existence, type, and severity of defects, providing a basis for the evaluation of the defect's impact on personal and professional performance (5). Color vision discrimination deteriorates with progressing age (6). Ocular diseases such as cataract and glaucoma, trauma, and certain medications also affect color vision (7). Chromatic discrimination is assessed using various color vision tests (8-9).

In European Caucasians the prevalence of color vision deficiency is about 8% in men and about 0.4% in women and between 4% and 6.5% in men of Chinese and Japanese ethnicity, respectively (10). Some regional prevalence studies showed diversity in prevalence such as Turkey (7.3%), Iran (4.7%), India (2.8% to 8.2%, ethnic variations) and Saudi Arabia (2.9%) (11). While in Pakistan, color vision deficiency (CVD) ranges from 0.9%, 2.48% and 2.78% (12-14).

## METHODS

This cross-sectional study with non-probability convenience sampling was carried out in the Department of Ophthalmology and Visual Science, Dow University of Health Science and Isra School of Optometry, Al-Ibrahim eye hospital, Karachi, Pakistan. Both male and female patients were included. The protocol for examination for all patients who met our inclusion exclusion criteria were filled. Visual acuity was recorded separately both for near and distance vision, with and without glasses and with pinhole. A total of 160 eyes were enrolled with 80 eyes pseudophakic and 80 eyes phakic. The patients aged between 45 years to 60 years old having Phacoemulsification surgery with Acrylic IOL implant, came for follow-up after one month were included. All types of refractive errors after cataract extraction and visual acuity ranges from 6/6 to 6/18 were included. Posterior sub capsular opacity and other types of cataract surgeries and systemic diseases were excluded. Panel D15 test was performed at 33cm distance to find the changes in color vision. Self-prepared proforma was used for collection of data.

### Statistical methods

Statistical analysis was performed using statistical package for social science (SPSS) version 20.0. All the categorical variables were presented as frequencies and percentages.

## RESULTS

The eyes were categorized in two groups: Phakic group with 80 (50%) eyes and pseudophakic group with 80(50%) eyes in a total sample of 160 eyes. All included sample was examined for right and left eye separately. Among them 86 (54%) were right eyes and 74 (46%) were left eyes. The visual acuity both in pseudophakic and phakic, 6/18 were in 5 (6%) pseudophakic eyes, 6/12 in 8 (10%), 6/9 in 32 (40%) and 6/6 in 3 (44%) eyes. But in phakic, 6/18 were 3 (4%), 6/12 in 5 (6%), 6/9 in 14 (18%) and 6/6 in 58 (73%) eyes as shown in Table 1.

**Table 1. Distance visual acuity**

Visual acuity	Groups				Total Eyes
	pseudophakic	Percentage%	Phakic	Percentage%	
6/18	5	(6%)	3	(4%)	8
6/12	8	(10%)	5	(6%)	13
6/9	32	(40%)	14	(18%)	46
6/6	3	(44%)	58	(73%)	93
Total	80	(100%)	80	(100%)	160

The near vision in both groups pseudophakic and phakic; N6 in 45 (52%) pseudophakic eyes and N8 in 35(47%) pseudophakic eyes, but in phakic 41 (48%) eyes with N6 and 39 (53%) eyes with N8 as shown in Table 2.

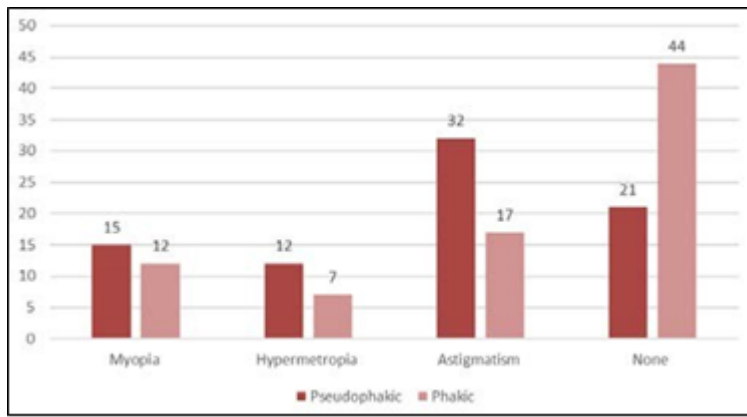
**Table 2. Near visual acuity**

Group	Near Vision				Total Eyes
	N6	Percentage%	N8	Percentage%	
pseudophakic	45	52%	35	47 %	80
Phakic	41	48 %	39	53 %	80
Total	86	100 %	74	100 %	160

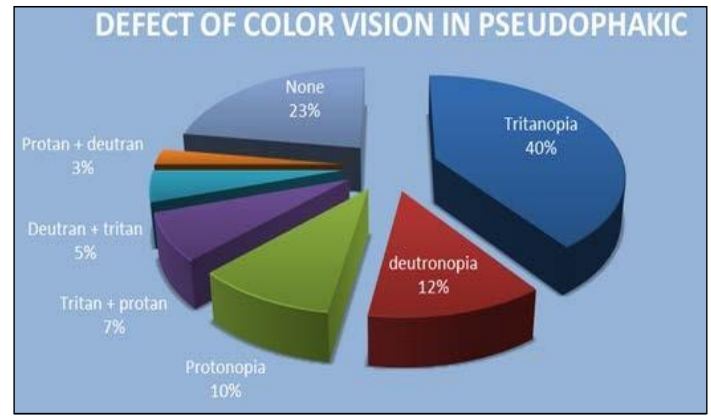
In Pseudophakic group myopes were 15 (19%), hyper metropes 12 (15%), astigmatic 32 (40%) and 21 (26%) had no refractive error. In phakic group myopes were 12 (15%), hypermetropes 7 (9%), astigmatic 17 (21%) and 44 (55%) had no refractive error as shown in Figure 1. Among pseudophakic group; tritonopia in 32 (40%), deuteronopia in 10 (13%), protonopia in 8 (10%), combined tritonopia+protonopia in 6(8%), combined deutran+tritan in 4 (5%), combined protan + deutran in 2 (3%) eyes while 18 (23%) eyes showed no color vision defect as shown in Figure 2.

The color vision defect in Pseudophakic Group when compared with Phakic Group (Figure 4), the pseudophakic eyes were more sensitive to tritanopia 32 (40%) as compared to phakic 7 (9%), than deuteronopia 10 (13%) in pseudophakic group and only 1(9%) in phakic group, protonopia 8(10%)in pseudophakic and 0 (zero) in phakic and the combined tritonopia+protonopia defect 6 (8%) in pseudophakic but 0 (zero) in phakic, then combined deuteronopia + tritonopia 4 (5%) in pseudophakic and 0 (zero) in phakic group, combined protonopia +deuteronopia 2 (3%) in pseudophakic and 0 (zero) in phakic while 18 (23%) in pseudophakic and 72 (90%) in phakic group has no color vision defect.

**Figure 1: Type of refractive errors in Pseudophakic and phakic groups**

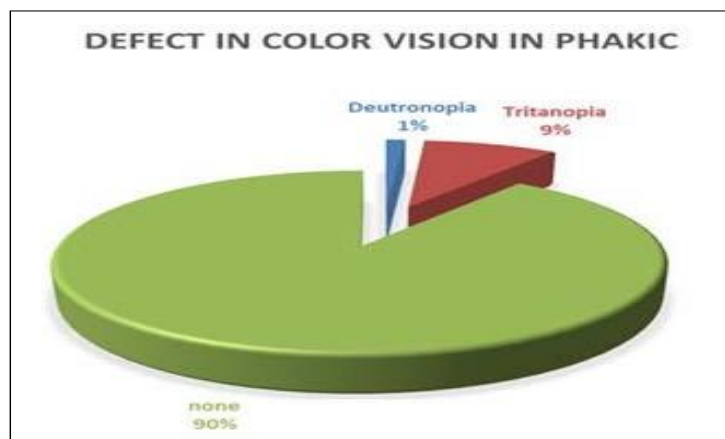


**Figure 2: Defect of color vision in Pseudophakic Group**

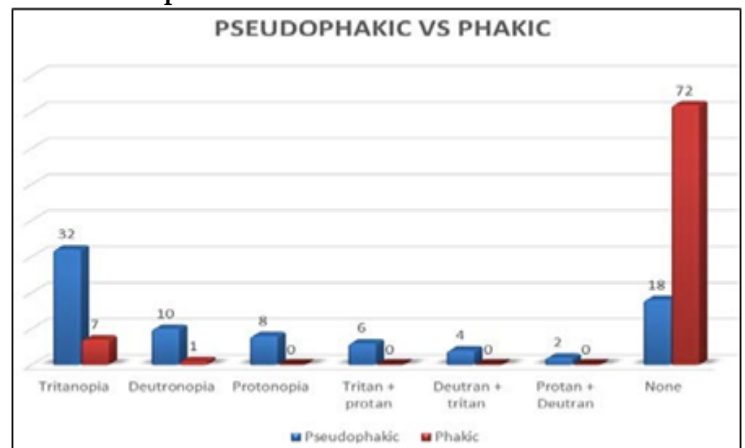


In phakic group: Tritanopia in 7 (9%) eyes and Deutronopia 1(1.00%) while 72 (90%) had no defect as shown in Figure 3.

**Figure 3: Defect of color vision in phakic Group**



**Figure 4: Color vision defect in Pseudophakic Group vs Phakic Group**



## DISCUSSION

In the present study Pseudophakic group was more sensitive to tritanopia which contradict with the results of another study where anomaloscope and the 100-hue test were used indicating that the pseudophakic eyes were more sensitive to red and less sensitive to blue than healthy phakic eyes (15).

A study conducted on sixty-eight eyes of 40 diabetic patients, divided into four subgroups based on different stages of diabetic retinopathy, and 20 eyes of 10 healthy controls, demonstrated that only 51% of diabetic patients passed the Ishihara pseudoisochromatic plates test, 28% failed, and 21% were classified as suspects, whereas 90% of controls passed and 10% failed. In the Farnsworth D-15 test, only 10% of controls failed, due to protanopia, while 50% of diabetic patients showed test failure, exhibiting various forms of dyschromatopsia, predominantly tritanopia and combined color vision deficiencies. These findings contrast with our study, which excluded participants with systemic diseases (16).

Another cross-sectional study used the Farnsworth 100 hue test and Pickford-Nicholson anomaloscope in pseudophakic, phakic, and spectacle aphakic eyes to determine the minimal difference in their color perception. The pseudophakic eyes were highly sensitive to red and less sensitive to blue when compared with aphakic eyes, while in our study, Panel D15 was used to assess color vision defects and showed contrary results, indicating that pseudophakic eyes were sensitive to blue(17). A study showed that blue-yellow defects became increasingly prevalent with increasing age (18) similar to our study's results.

Another study compared color differentiation of 30 phakic and 30 pseudophakic eyes using the Farnsworth-Munsell 100-hue test, and they found no significant difference between the two groups regarding color differentiation, although theoretically it could be expected that color differentiation would be better in eyes with a synthetic

intraocular lens and depending on the subject's age (19). It has the greatest influence on color sense, while our study showed that the pseudophakic group is more sensitive to blue defects compared to the phakic group.

## CONCLUSION

The study concluded that tritanopia was more commonly present in Pseudophakic group while majority of subjects in Phakic group did not show color vision defect.

## Conflict of Interest

Authors declare no conflict of interest.

## Ethical consideration

The study was approved by local research ethics committee.

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