Comparative Study of Effectiveness between Color Blindness Test Plate and Traffic Light Simulator for Thai Driving License Test: Pilot Study

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Abstract

Objective: To compare the effectiveness between color blindness test plate and traffic light simulator for Thai driving license test

Materials and methods: A prospective, interventional pilot study was performed in 28 patients with color vision deficiency (age range 20-66 years). Each patient underwent color blindness exam with color blindness test plate and traffic light simulator. The patient is considred to have passed if he identifies all of the colors correctly from two out of three times Primary outcome measure was pass rate each of test. Chi-square statistical analysis was used to compare the results between 2 exams.

Results: The results showed no statistically significant differences of the pass rate between the color blindness test and traffic light simulator (75% versus 64.3%, respectively ;p=0.383) In addition, the age and severity of color blindness were not different (p= 0.567, p=0.483, respectively) between passed and not passed groups.

Conclusions: The color blindness test plate and traffic light simulator demonstrated equal efficacy for examining driving license in Thai individuals with color vision deficiency, supporting the use of color blindness test plate and traffic light simulator for Thai driving license examination.

Keywords: Thai driving license test, Color vision deficiency, Color blindness

Introduction

In general, the majority of those with color blindness except for a few mildly affected deuteranomaly, reported that they experience problems with color in everyday life and at work included driving[1].

Although some countries removed the requirement for color blindness test in driving license[2], Thailand remains one of the countries which still has restrictions for color vision deficiency people. The purpose for color blindness testing in driving license is to distinguish between the colors red, green and amber.

The regulation of Thai driving license from Department of Land Transport require examinee to pass color blindness test. There are 2 means to test color blindness in Thailand, color blindness test plate (designed by Department of Land Transport) and traffic light simulator. Prior to 2010, Thailand used only color blindness test plate for Thai driving license testing and then after that they used traffic light simulator for another means of testing because they believed that this mean can affect the real circumstance for daily driving. However, Thailand still uses both means to test for driving license due to economical reasons. The test centers can choose either one of them.

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The authors have concern whether these 2 means have the same effectiveness, so that all examinees will have justness in testing. The rationale of this study is to compare the effectiveness between color blindness test plate and traffic light simulator for Thai driving license test

Methods

Our study was approved by the Human Research Ethics Committee of the Faculty of Medicine (MTU-EC-OP-2-265/63), Thammasat University, Thailand. We performed a tool diagnostic study by collecting data from examination and diagnosis with color vision deficiency at the Ophthalmology Department in Thammasat university hospital during 23-24 April 2021. Our inclusion criteria were those older than 18 years and diagnosed with color vision deficiency by Ishihara test. We excluded patients who have visual acuity less than 20/80 by Snellen chart, and previous history of retina or optic nerve damage. The participants received details of the research and signed a consent form before participating. The participants underwent a color vision test with an Ishihara test, and a Farnsworth 15 hue test to evaluate the severity

of color vision deficiency then the participants stood 3 meters away from the color blindness test plate (figure 1). The researchers pointed at the red, green or yellow color on test plate and asked the participants to identify the color, repeating for 3 times per color. If the participants answered the correct color for at least 2 (out of 3) times, they were considered as "pass". The participants correctly identify all 3 colors to pass the exam. Then, the participants were asked to stand 3 meters away from the traffic light simulator (figure 2). The researchers started the exam by pushing the button from the controller and then the light color were randomly shown on the simulator. If the participants answered the correct color at least 2 (out of 3) times, they were considered as "pass". The participants must pass all 3 colors to pass the exam. The participants were tested under the same environment between 2 exams.

Statistical analyses were performed using the SPSS version 18.0 (Chicago, IL, USA). The demographic variables were analysed using descriptive statistics. To compare pass rate between 2 tests, Chi-square statistic were used. P value <0.05 was taken as statistically significant.

Figure 1 Color blindness test plate

Figure 2 Traffic light simulator

Results

Twenty eight patients were included with ages ranging from 20 to 66 years. Themean age was 34.61 years. All patients were male. All patients had a confirmeddiagnosis of color vision deficiency by Ishihara's test. From Farnsworth d-15 test, 4 patients (14.3%) had mild red-green color vision deficiency, 18 patients (64.3%) had medium green color vision deficiency, 4 patients (14.3%) had strong green color vision deficiency, 1 (3.6%) patient had medium red color vision deficiency and 1 patient (3.6%) had strong red color vision deficiency

Table 1 Patient Demographics

	Total (n=28)	
	N	**%**
Sex (male)	28	100%
Ishihara test (abnormal)	28	100%
Age		
20-29	10	35.7%
30-39	11	39.3%
≥40	7	25.0%
Mean±SD	34.61	±11.33
Min - max	20	- 66
Farnsworth d-15 test		
Mild red-green deficiency	4	14.3%
medium green deficiency	18	64.3%
strong green deficiency	4	14.3%
medium red deficiency	1	3.6%
strong red deficiency	1	3.6%

For   color

blindness test plate exam,

- 21 patients (75%) passed the exam (4,11,4,1,1 of them have mild red-green, medium green, strong green, medium red and strong red color vision deficiency respectively)

- 7 patients (25%) did not pass the exam (all of them have medium green color vision deficiency). In the "not pass" group, 4 patients (14.3%) answered wrong green color and 3 patients (10.7%) answered wrong red color

For traffic light simulator exam,

- 18 patients (64.3%) passed (3,12,2,1 of them have mild red-green, medium green, strong green and medium red color vision deficiency respectively)

- 10 patients (35.7%) did not pass the exam (1,6,2,1,1 of them have mild red-green, medium green, strong green, medium red and strong red color vision deficiency respectively). In the "not pass" group, 1 patients (3.6%) answered wrong red color (this patient has medium red color vision deficiency), 8 patients (28.6%) answered wrong yellow color (5, 2 and 1 of them have medium red, strong red and mild red green color vision deficiency respectively), 1 patients (3.6%) answered wrong yellow and green color (this patient has strong green color vision deficiency)

According to 2 exams, 15 patients (53.6%) did not pass at least one exam, 13 patients (46.4%) passed both exams and 2 patients (7.1%) did not pass both exams

Table 2 Results of examination with color blindness test plate and traffic light simulator

	Total (n=28)	
	N	**%**
Color blindness test plate		
passed	21	75.0%
not passed	7	25.0%
Green	4	14.3%
Red	3	10.7%
Traffic light simulator		
passed	18	64.3%
not passed	10	35.7%
red	1	3.6%
yellow	8	28.6%
yellow, green	1	3.6%
Results		
not passed at least 1 exam	15	53.6%
Passed both	13	46.4%
Not passed both	2	7.1%

Table 3 Results of examination with color blindness test plate and traffic light simulator classified by severity of color blindness

	Exams				p-value
	Color blindness test plate (n=28)		Traffic light simulator (n=28)		
	n	%	n	%	
Results					0.383
passed	21	75.0%	18	64.3%	
Not passed	7	25.0%	10	35.7%	
Farnsworth d-15 test					
Mild red-green deficiency					1.000
passed	4	100%	3	75.0%	
Not passed	0	0%	1	25.0%	
medium green deficiency					0.729
passed	11	61.1%	12	66.7%	
Not passed	7	38.9%	6	33.3%	
strong green deficiency					0.429
passed	4	100%	2	50%	
Not passed	0	0%	2	50%	
Medium red deficiency					-
passed	1	100%	1	100%	
Not passed					
strong red deficiency					1.000
passed	1	100%	0	0%	
Not passed	0	0%	1	100%	

p-value from Chi-square test or Fisher's exact

Chi-square test was used to compare the pass rate between the two exams. P-value was 0.383(>0.005) (Table 4)

Table 4 Comparison the results between color blindness test plate and traffic light simulator

	Total (n=56)		Color blindness test plate (n=28)		Traffic light simulator (n=28)		p-value
	n	%	n	%	n	%	
results							0.383
Pass	**39**	69.6%	21	75.0%	18	64.3%	
Not pass	17	30.4%	7	25.0%	10	35.7%	

p-value from Chi-square test

According to age and severity of color vision deficiency between two groups (passed & not passed), there was no difference between the groups (p=0.567, 0.489 respectively) (table 5)

Table 5 Comparison age and severity of color vision deficiency between two exams

	Results				p-value
	Not passed (n=15)		passed (n=13)		
	n	%	n	%	
Age					0.567
20-29	4	26.7%	6	46.2%	
30-39	7	46.7%	4	30.8%	
≥40	4	26.7%	3	23.1%	
Mean±SD					
Farnsworth d-15 test					0.483
Mild red-green deficiency	1	6.7%	3	23.1%	
medium green deficiency	11	73.3%	7	53.8%	
strong green deficiency	2	13.3%	2	15.4%	
medium red deficiency	0	0%	1	7.7%	
strong red deficiency	1	6.7%	0	0%	

p-value from Fisher's Exact Test

Discussion

Congenital color vision deficiency is inherited in an X-linked recessive pattern, making it much more common in males than in females (8% and 0.5% respectively). It is still controversial whether color vision deficiency affect the ability to drive. Verriest et al (1980) claimed definite proof that color-defective drivers do not have more accidents than people with normal color vision. However, it is shown that protans have significantly more rear-end collisions and other accidents caused by overlooking signal lights. Deutans had more accidents at traffic lights[3,4]. David A Atchinson et al (2003) found that for color vision deficiency, response times to red lights increased with increase in severity of color vision deficiency, with deutans performing worse than protans of similar severity and for green lights, response times of all groups were similar[5]. Antonio et al (2004) found that people with defective color vision preferred daytime driving. At night, subjects with defective colour vision had difficulty identifying reflectors on the road and the rear signal lights of cars[6,8].

As mentioned earlier, the regulations of Thai driving license from Department of Land Transport require examinee to pass color blindness test. There are 2 means to test color blindness in Thailand, color blindness test plate (designed by Department of Land Transport) and traffic light simulator.

In this pilot study, we gathered 28 participants who have best corrected visual acuity better than 20/80 in both eyes because from the study of RR Sehlapelo and AO Oduntan said that VA worse than 20/80 may affect the color vision results[7]. All participants were male. All age groups participated in this study, so we assumed this can reflect the effectiveness of the exams in all age. All severity of red and green color deficiencies were included in this study. We found that medium green color vision deficiency was most diagnosed with Farnsworth d-15 test (64.3%).

We found that color blindness test plate exam had more percentage of passing than traffic light simulator exam (75% vs 64.3%). However, there were no statistically significant differences in passing rate between 2 exams (p = 0.383).

This mean that 2 exams can be substituted to each other to distinguish red, green and amber color. We deduced that these two means were not different due to the ability to learn to discriminate the colors. We also found that there was no difference in age and severity of color vision deficiency between those who passed or failed.

Besides the means of the exam, the author believed that the color conspicuity of both exams has effect on testing. Because we interviewed some of the participants and they said that some of the test centers use old exam that cause less contrast in color and it's more difficult for them to answer correctly. O'Brien KA et al. (2002) stated that redundant color coding does contribute to the conspicuity of signs and signals[9].

It is also important to appreciate other factors which might affect the discrimation of traffic light color such as as the various mental states (fatigue, alcohol intake, psychological problems), cautious[10,11].

The main limitations of this study included a relatively small sample size, and in future studies a bigger size could be involved to help determine subgroup analysis.

Conclusion

There is no difference in effectiveness (in terms of passing rate) between the color blindness test plate and traffic light simulator for Thai driving license exam. However, the study is small, further study with larger number is recommended.

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