

COMPARISON OF KRIMSKY AND PRISM COVER TEST FOR MEASUREMENT OF DEVIATION AMONG SQUINT PATIENTS

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ABSTRACT

OBJECTIVE: To compare krimsky test and prism cover test for evaluation which test is better for measurement of angle of deviation among squint patients.

MATERIALS AND METHODS: A cross-sectional study was conducted at eye out patient department (OPD) of Shalamar Hospital, Lahore from August 2023 to January 2024. Data of 34 children (either gender, 6-16 years, concomitant strabismus) was collected using non-probability purposive sampling technique. Patients with incomitant strabismus, any other ocular pathology and those with any ocular surgery were excluded. All tests were performed using standard protocols. Data analysis was done using SPSS 25. Numerical data like age and qualitative data like gender, history like family, fever, trauma, patching, spectacles, surgery, when crossing of eyes first observed by parents, etc. were presented in the form of Frequency (Percentage). After fulfilling the desired parameters, Chi-square test was used to determine the association between Krimsky test & Prism cover test.

RESULTS: A total of 34 children (16 males and 18 females) were recruited for this study from the age of 6 to 16 years, with an average mean age \pm standard deviation of 2.921 ± 3.294 years. 11 participants out of 34 had myopia (32.4%), 13 had hypermetropia (38.2%), 4 had astigmatism (11.8%), 6 were emmetrope (17.6%). When the Krimsky and PCT were done for comparison patients with <30 PD were 13 (38.2%), 30- 45PD were 12 (35.3%), 45-

60PD were 5(14.7%) and 60-75PD were 4(11.8%). The p- value was less than 0.05(p-value 0.001) which means results were significant.

CONCLUSION:Frequency of females were higher than males but had no significant association of age, gender, family history, history of trauma, history of fever with the strabismus. Although strong correlation was found between krimsky and prism cover test as p value was less than 0.05 (<0.001).

INTRODUCTION

Strabismus is a state which involves the misalignment of the eyes. It can cause the misaligned eye to deviate inward or outward or, infrequently, to turn up or down. It is frequently diagnosed in children but can occur at any age(Kraus Courtney 2023). The variability of strabismus-related ocular misalignment has been the subject of numerous studies. Measurement of angle of deviation correctly is critical(Heber Anandan 2021). Accurate estimation of the angle of deviation is necessary for preoperative assessments, operative techniques and postoperative evaluation(Tengtrisorn S 2021). Total angle of deviation measured is equal to the amount of prism necessary to center the corneal light reflex on the pupil of the strabismic eye(Mark M Miller 2022).

Measurement of angle of deviation is useful to determine the extent of surgery needed or the appropriate prescription of therapeutic prisms (Harindersinghsethi 2017). Prescribing prisms is a complex process that requires expertise and collaboration among optometrists, orthoptists, and ophthalmologist to have a deep understanding of the underlying causes of symptoms (headaches, eye strain, and visual fatigue) in order to effectively treat patients. Therefore, it is crucial for eye healthcare providers to have a solid foundation in the evaluation and prescription of prisms(Kirandeepkaur 2023). Prism cover test is common to measure the angle of deviation in strabismic patients that can only be employed in case of enough

vision for fixation while Krimsky test uses reflection of cornea to measure deviation(Joo KS 2013).

Worldwidely, horizontal deviation is (exotropia, esotropia) is most common type assessed clinically. The overall prevalence of any strabismus, exotropia and esotropia was 1.93%, 1.23%, and 0.77%, respectively. 1.535 to 17.9% was the prevalence of strabismus globally. The most common risk factors that are associated with the development of strabismus includes, family history, ethnicity, genetic conditions, smoking, prematurity, low birth weight, refractive error and neuro disability(MebratuMulusewTegegne 2021). Regionally, in China, at Nanjing Eye Study (NES) a total of 109 children with age of 48 to <60 months were diagnosed with strabismus, while the overall rate of prevalence was 5.56% (95% CI 4.54% to 6.57%). Concomitant exotropia and concomitant esotropia prevalence was 4.84% (95% CI 3.89% to 5.79%) and 0.56% (95% CI 0.23% to 0.89%). In the overall prevalence of strabismus(5.95% vs 5.08%), concomitant esotropia(0.745% vs 0.34%) or concomitant exotropia(5.02% vs 4.63%) there was no gender difference (Yue Wang 2021).

Locally in Pakistan, the prevalence of strabismus which was assessed through a research in Karachi was 6.2% in total number of patients, while, according to the number of patients taken in the study the prevalence was 5.25%. 6-9 years was the most common age group (46%). Alternate esotropia was found most frequently (16.1%) and manifest

strabismus was most common. Most of the cases includes, esotropia(45.97%), exotropia(28.73%), third nerve palsies(3.44%), duane retraction syndrome(1.14%), nystagmus(3.44%), amblyopia(3.44%), esophoria(2.99%), exophoria(3.44%) and pseudostrabismus (8.045%). There was a high prevalence of strabismus and manifest strabismus was more than latent strabismus(Paras Azam 2019).

Position of eyes is controlled by extraocular muscles. Thus, paralytic strabismus occurs only when there is problem in muscles or the nerves controlling them. Cranial nerve III, IV and VI control the extraocular muscles. Eye may deviate down or out when there occurs an impairment of cranial nerve III. The eye is moved up or slightly inward when there is an impairment of cranial nerve IV which may be congenital. Eye may deviate inward due Impairment of cranial nerve VI and has many causes due to long path of nerve. Nerve can be compressed due to increased cranial pressure as it is between clivus and brain stem. Cranial nerve VI can also be damaged if the doctor is not careful during forceps delivery and baby's neck can be twisted. It shows that a cause for strabismus lie with the input provided to visual cortex. Brain learns to interpret the signals that come from an eye through a process called visual development, occurs in first seven to eight years of life. If child always fixates with one and never fixates with other, development may be interrupted by strabismus. Signal from deviated eye is suppressed to avoid double vision and constant suppression causes visual development failure(Dr. Jayantilal Shah 2013).

In strabismus, deviation is present and at point of fixation, visual axis is unable to intersect. The misaligned image from both causes double vision or, in children image from deviating eye is suppressed at cortical level. In childhood, squint may occur due of failure of normal development of binocular fusion system or oculomotor imbalance.

Failure of fusion, secondary to poor vision in one eye may develop squint due mechanical restriction or weakness of muscles, or damage to the nerve supply. When the fovea is temporal to centre of posterior pole resulting in nasal displacement of corneal reflex and positive at that point and negative when converse applies. Appearance of squint occurs when the angle kappa is large. Accurate measurement of angle of deviation is important for the surgical and therapeutic procedures. Krimsky is the test for measurement of angle of deviation in which prism is placed in front of the deviating eye and light is shone into the eye to align the corneal reflex. The power of prism is increased until corneal reflex of both the eyes are equal. While, in prism cover test, prism is placed in front of the fixating eye and occlude is used to cover the alternate eyes, amount of prism is increased until there is no movement seen left. Higher risk of having esotropia and exotropia are prematurity and maternal smoking during pregnancy(Susan Cotter 2011).

Serious complication of strabismus surgery is scleral perforation, when attempting to reattach extraocular muscle to wall of eye as needle is unintentionally through full thickness sclera into suproscleral space or through retina(John A Bradbury 2017).

S Tengtrisorn et al, 2021 conducted a “cross-sectional study” in Songklanagrind Hospital, Thailand to “compare the angle of deviation measured from Photo-Hirschberg testing and Krimsky testing, with that from an alternate prism cover test (APCT) in strabismus patients”. In this study 33 strabismus patients were photographed for analysis by photo-Hirschberg testing using computeure software technique while 28 patients were tested with Krimsky test. In these the “exclusion criteria, in which 4 intermittent exotropia cases, 1 intermittent esotropia case and 2 which cases missing data for krimsky test were excluded and inclusion criteria, in which patients with

esotropia and exotropia were included” were calculated. The corneal light reflex displacement, converted into prism diopter (PD), was compared to the angle of deviation measured with APCT. The mean±SD of the deviation angle measured by APCT with a fixation target at 30 cm and 6 m; were 48.09±16.34PD and 47.82±15.73 PD, respectively. At 1 m, the difference in the angle of deviation measured from APCT and the Photo-Hirschberg test within 10 PD were 58.8% and 63.6%, for ET and XT, respectively. The difference in the angle of deviation measured from APCT and Krimsky tests within 10 PD in ET and XT were 80.0% and 70.0%, respectively. On behalf of all authors the corresponding author declares that no competing interests exist (Tengtrisorn S 2021).

MATERIALS AND METHODS

Study design was cross-sectional study in the setting of Eye OPD of Shalamar hospital, Lahore, Pakistan in duration of six months (August 2023-January 2024). The sample size of the study was 34 which was calculated using this formulae Two proportions = $\frac{Z_{1-\alpha/2} \sqrt{P_1(1-P_1) + P_2(1-P_2)}}{P_1 - P_2}$ Z1- $\alpha/2$ = Level of Significance 95.0% (1.96), Z1- β = Power of the study 99.0% (1.99), P1 = Expected Proportion of one group 86.7% (0.86), P2 = Expected Proportion of other group 58.8% (0.58). Sampling technique was Non-Probability, Purposive sampling technique. Study instruments were Pen torch (Rilekh medical pen torch), Occluder, Log Mar Chart, Trial box and frame, Loose prisms, Prism bar, Cycloplegic eye drops and Accommodative targets for near and distance. Inclusion criteria included children of age group 6 to 16 years, subjects with comitant strabismus, children of either gender. While exclusion criteria excluded subjects with incomitant strabismus, subject with any other ocular pathology, subjects who have undergone any ocular surgery. In data collection procedure the data was collected at

Eye Department of Shalamar Hospital, Lahore after the approval of Shalamar Medical and Dental College IRB. After explaining the objective of study to the patients and asking the patients if they want to participate in the research, a consent form was signed from the patient’s parent. Patients with strabismus was taken for performing the test. Each test was performed on same subject. The data was collected at Eye Department of Shalamar Hospital, Lahore. No further investigations were required for this study. There was no risk to the participants but they had experienced light sensitivity and felt little fatigue. The patient arrived in eye OPD of shalmar hospital, after that the patient was approached along with parents. History of eye deviation (Duration, family history, which eye, intermittent or persistent, congenital or acquired) was taken from the parents. The instruments used to collect data were prisms, prism bars, torch, occluder, accommodative targets for near and distance, log mar charts. These instruments were used to check the visual acuity and angle of deviation. After taking all the history, corneal reflex was checked by doing photo hirschberg test, then cover uncover test was performed to check if the deviation is manifest or latent. All the subjects were undergone full examination through krimsky and prism cover test to measure the angle of deviation in these subjects with strabismus. The prism cover test was performed by placing the prism of different power in appropriate direction for deviation on the non-fixing eye while placing an occluder on the fixing eye until the deviation was neutralized. Krimsky test is another method for measuring the angle of deviation in which the prism is placed in front of fixing eye with apex pointing towards deviation. The prism which fixed the corneal reflex in center of both pupils was indication to the angle of deviation. Statistical analysis was done as the data was entered and analyzed using SPSS 25. Numerical data like

age and qualitative data like gender, history like family, fever, trauma, patching, spectacles, surgery, when crossing of eyes first observed by parents, etc. were presented in the form of Frequency (Percentage). After fulfilling desired parameters. Chi-square test was used to determine the association between Krimsky test & Prism cover test. Ethical issues: The privacy of the patient was protected. Patient information was only accessible to the research team.

RESULTS

A total of 34 children (16 males and 18 females) were recruited for this study from the age of 6 to 16 years, with an average mean age ± standard deviation of 2.921±3.294 years. 11 participants out of 34 had myopia(32.4%), 13 had hypermetropia(38.2%), 4 had astigmatism(11.8%), 6 were emmetrope(17.6%).

Table 1 Frequency of Males and Females

Gender	Frequency	Percentage
Male	16	47.1
Female	18	52.9
Total	34	100.0

Gender Frequency Percentage Male 16 47.1 Female 18 52.9 Total 34 100.0
 In this study 16(47.1) were male and 18(52.9) were females.

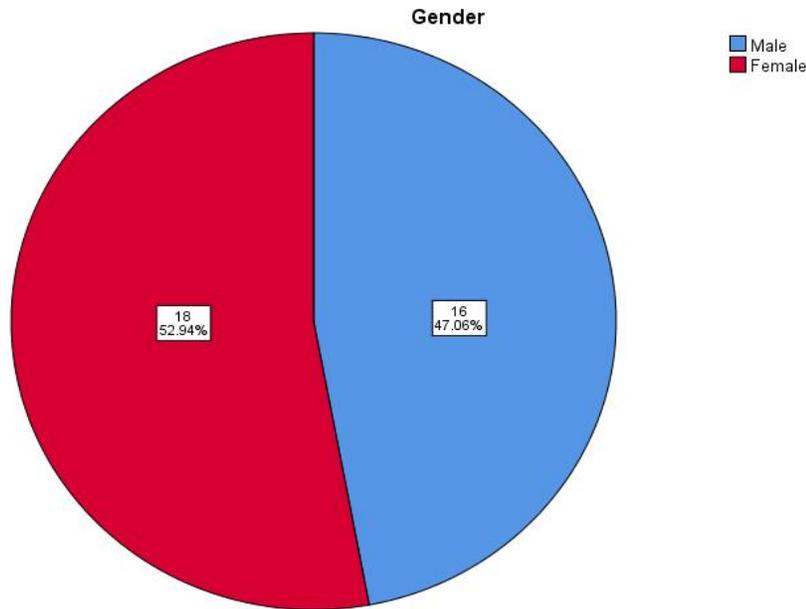


Figure 1 Pie chart showing distribution of gender

Table 2 Comparison of Photohirschberg test with PCT(OD)

Photo-hirschberg test	Prism Cover Test OD				Total
	<30 prism diopter	30-45 prism diopter	45-60 prism diopter	60-75 prism diopter	
Central	4(80.0%)	0(0.0%)	1(20.0%)	0(0.0%)	5(100.0%)
Nasal	6(54.5%)	2(18.2%)	3(27.3%)	0(0.0%)	11(100.0%)
Temporal	3(17.6%)	2(41.2%)	5(29.4%)	7(11.8%)	17(100.0%)
Total	13(39.4%)	9(27.3%)	9(27.3%)	2(6.1%)	33(100.0%)

Likelihood Ratio 11.688

Among all subjects, patients with corneal reflex at <30 PD were 13(39.4%), with 30-45PD were 9(27.3%), with 45-60PD were 9(27.3%) and with 60-75PD were 2(6.1%).

There was no statistically significant association between Photo Hirschberg test and Prism cover test OD outcome (p-value 0.069).

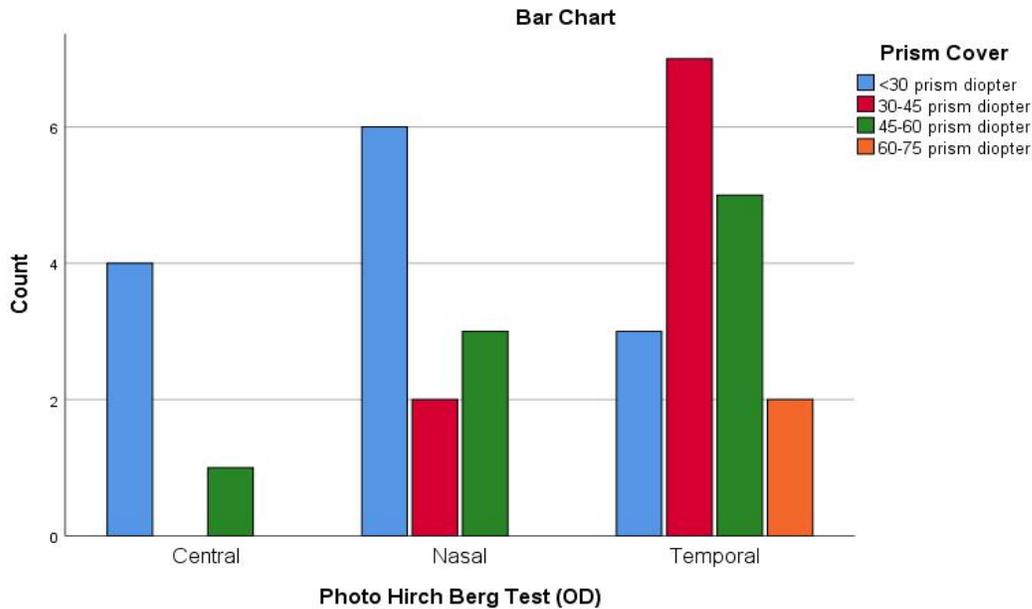


Figure2 Multiple bar chart showing comparison of photohirschberg test with PCT OD

Table 3 Comparison of photohirschberg test with krimsky test (OD)

Photo Hirsch Berg Test	Krimsky Test OD				Total
	<30 prism diopter	30-45 prism diopter	45-60 prism diopter	60-75 prism diopter	
Central	3(60.0%)	1(20.0%)	1(20.0%)	0(0.0%)	5(100.0%)
Nasal	6(54.5%)	3(27.3%)	2(18.2%)	0(0.0%)	11(100.0%)
Temporal	4(23.5%)	8(47.1%)	1(5.9%)	4(23.5%)	17(100.0%)
Total	13(39.4%)	12(36.4%)	4(12.1%)	4(12.1%)	33(100.0%)

Likelihood Ratio 9.994

Among all subjects, patients with corneal reflex at <30 PD were 13(39.4%), with 30-45PD were 12(36.4%), with 45-60PD were 4(12.1%) and with 60-75PD were

4(12.1%). There was no statistically significant association between Photo Hirschberg test and Krimsky Test OD (p-value 0.12).

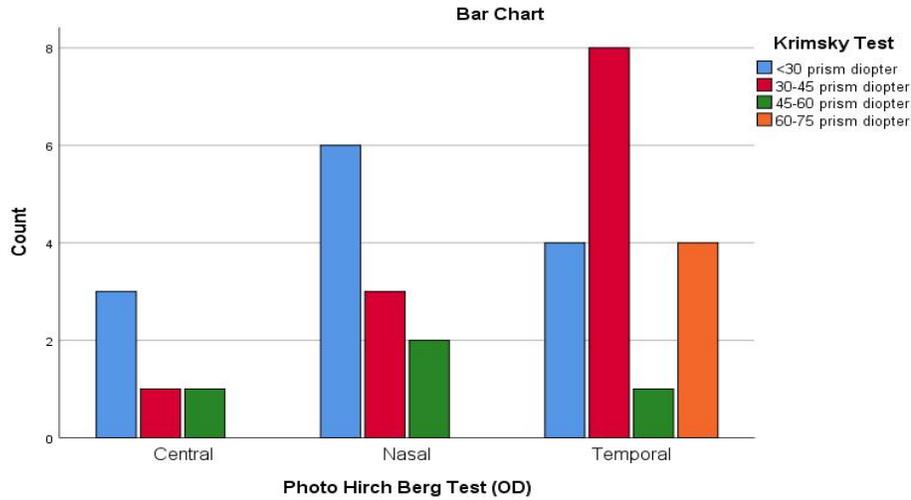


Figure 3 Multiple bar chart showing comparison of photohirschberg test with krimsky test OD

Table 4 Comparison of photohirschberg test with PCT (OD)

Photo Hirschberg Test	Prism Cover Test OS				Total
	<30 prism diopter	30-45 prism diopter	45-60 prism diopter	60-75 prism diopter	
Central	7(33.3%)	6(28.6%)	7(33.3%)	1(4.8%)	21(100.0%)
Nasal	2(33.3%)	2(33.3%)	2(33.3%)	0(0.0%)	6(100.0%)
Temporal	2(66.7%)	1(33.3%)	0(0.0%)	0(0.0%)	3(100.0%)
Total	11(36.7%)	9(30.0%)	9(30.0%)	1(3.3%)	30(100.0%)

Likelihood Ratio 3.332

Among all subjects, patients with corneal reflex at <30 PD were 11(36.7%), with 30-45PD were 9(30.0%), with 45-60PD were 9(30.0%) and with 60-75PD were 1(3.3%).There was no statistically significant association between Photo Hirschberg Test and Prism Cover Test OS (p-value 0.766).

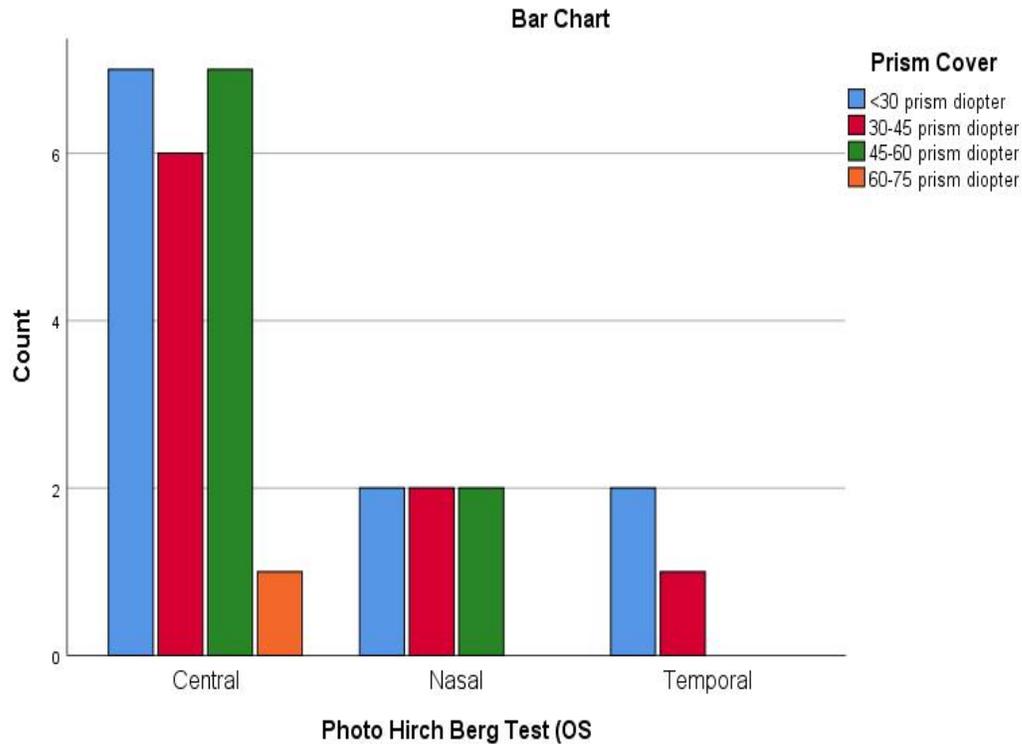


Figure4 Multiple bar chart showing comparison of photohirschberg test with PCT OS

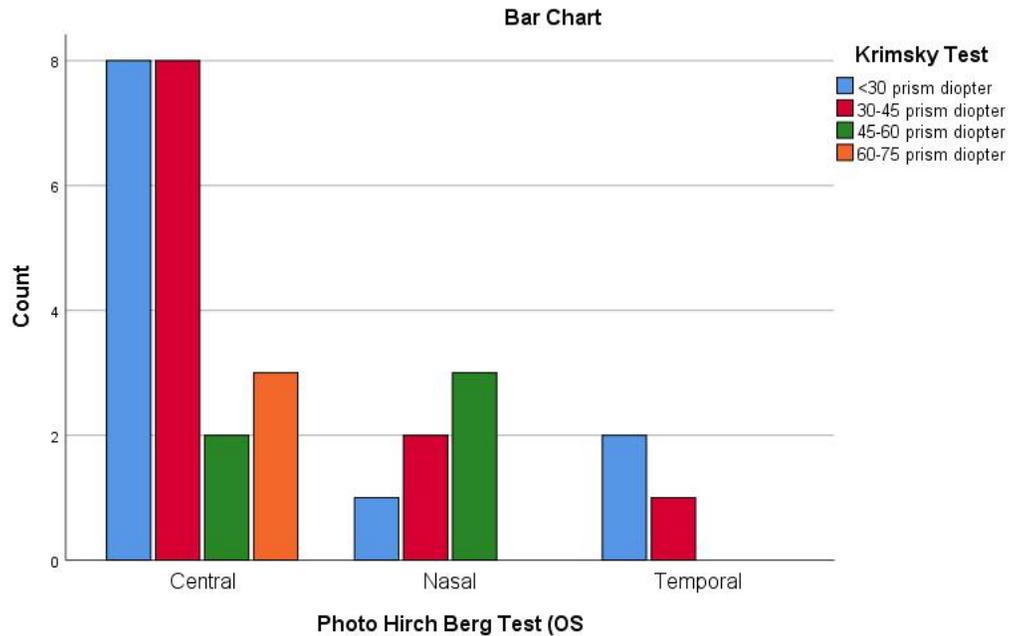
Table 5 Comparison of photohirschberg test with krimsky test(OS)

Photo Hirschberg Test	Krimsky Test OS				Total
	<30 prism diopter	30-45 prism diopter	45-60 prism diopter	60-75 prism diopter	
Central	8(38.1%)	8(38.1%)	2(9.5%)	3(14.3%)	21(100.0%)
Nasal	1(16.7%)	2(33.3%)	3(50.0%)	0(0.0%)	6(100.0%)
Temporal	2(66.7%)	1(33.3%)	0(0.0%)	0(0.0%)	3(100.0%)
Total	11(36.7%)	11(36.7%)	5(16.7%)	3(10.0%)	30(100.0%)

Likelihood Ratio 7.959

Among all subjects, patients with corneal reflex at <30 PD were 11(36.7%), with 30-45PD were 11(36.7%), with 45-60PD were 5(16.7%) and with 60-75PD were 3(10.0%). There was no

statistically significant association between Photo Hirschberg Test and Krimsky Test OS (p-value



0.241).

Figure 5 Multiple bar chart showing comparison of photohirschberg test with krimsky test OS

Table 6 Comparison of krimsky and prism cover test

Prism Cover Test	Krimsky Test				Total
	<30 prism diopter	30-45 prism diopter	45-60 prism diopter	60-75 prism diopter	
<30 prism diopter	10(76.9%)	0(0.0%)	2(15.4%)	1(7.7%)	13(100.0%)
<30 prism diopter	2(20.0%)	7(70.0%)	1(10.0%)	0(0.0%)	10(100.0%)
<30 prism diopter	1(11.1%)	5(55.6%)	2(22.2%)	1(11.1%)	9(100.0%)
<30 prism diopter	0(0.0%)	0(0.0%)	0(0.0%)	2(100.0%)	2(100.0%)
Total	13(38.2%)	12(35.3%)	5(14.7%)	4(11.8%)	34(100.0%)

Likelihood Ratio 31.698

Among all subjects, patients corrected with <30PD with Krimsky test were 13(38.2%) and with PCT were also 13, while those corrected with 30-45PD were 12 in krimsky and 10 with PCT. In 45-60PD 5 were with

krimsky and 9 with PCT, while with 60-75PD 4 were with krimsky and 2 with PCT. The association between Krimsky and Prism Cover Test was statistically significant (p-value <0.001).

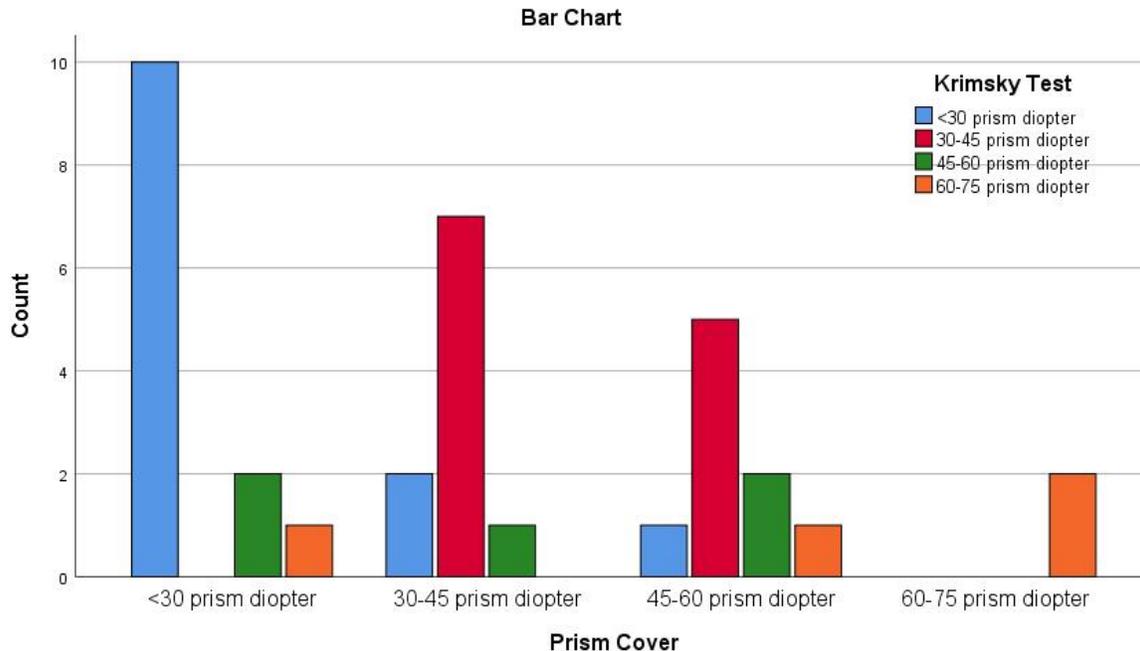


Figure 6 Multiple bar chart showing comparison of krimsky test and PCT

DISCUSSION

The accuracy of the angle deviation depends totally on the method of measurement, personnel experience and the patient cooperation. The krimsky and PCT were used to measure the deviation and compare which test was more accurate for measuring it.

In this study the frequency of male and females were compared where the frequency of female group(52.9%) was high as compared to males(47.1%). But there was no statistically significant association found in the results.

In this study the refractive variables were compared the ratio of myopia (32.4%), hyperopia(38.2%), anisometropia(11.8%) and emmetropia(17.6%) was seen. The highest ratio was of hyperopia. But there were no statistically significant association between refractive error and strabismus. (Paolo Esposito Veneruso 2018) concluded in their study that refractive error as hyperopia may cause strabismus which contradicted with this study.

In this study a statistically strong association was seen between Krimsky and Prism Cover

Test(p-value <0.001). Among all subjects 34 both Krimsky and Prism cover test were applied on each patient and then the results of both test were compared centrally, nasally, temporally with prisms of <30PD, 30-45PD, 45-60PD and 60-75PD. (Tengtrisorn S 2021) compared the degree of angle of deviation from APCT and Photo- Hirschberg tests, with values of the Hirschberg coefficients from photographs and using specific software. This study also compared the degree of angle of deviation from APCT and Krimsky tests. Photohirschberg test was compared with PCT by (Tengtrisorn S 2021) in which some association was seen as they use photohirschberg test in place of PCT for uncooperative patients.(Tengtrisorn S 2021) show moderately strong association in krimsky and PCT(0.773 and 0.738). This study showed similar results to our study. Another study showed similar results to our study. (Joo KS 2013) showed moderately strong correlation between APCT and Krimsky in ET and XT($r = 0.738, 0.651$) and very strong correlation between APCT and

Distance Krimsky tests in ET and XT($r = 0.981, 0.919$).

Meanwhile research of (Yoo YJ 2019) using infrared photographs, with a specific filter, measured the angle of deviation in small angle ET, and reported strong correlation($r = 0.815$) with both APCT and Krimsky tests.

CONCLUSION

The reliability of Prism Cover Test was better than Krimsky Test for measuring an angle of deviation. Measuring the accurate angle of deviation for pre and post-operative measures is necessary and it helps in surgical procedures. Accuracy of the test also aid in assessment of angle of strabismus.

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