Role of Pin Hole in Rapid Recognition of Refractive Error as Cause of Diminished Vision

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ABSTRACT

BACKGROUND

A tertiary healthcare set up receives an increasing load of patients with complaints of diminished vision on a daily basis. It can be quite cumbersome for conducting automated refractometry in each of them, on the suspicion of refractive error being the cause of vision loss. Few studies have shown a simple visual acuity comparison of individual eyes with and without pin-hole can determine if the patient has significant refractive error. There are minimal studies done to determine the reliability of such use of pin-hole, and even less of such studies are done in our country. The purpose of this research was to calculate the sensitivity and specificity of significant visual acuity change on using pin-hole in identifying refractive errors.

METHODS

Patients were selected in the age group of 15 years to 55 years with chief complaints of blurred / diminished / low vision. Patients with known history of diabetes, hypertension, trauma to eyes, and neurological/psychological complications were excluded from the study. Log MAR chart was used to measure the visual acuity in the selected subjects. Visual acuity was recorded for individual eye in each patient; first without, and then with pin-hole. An improvement in vision by at least one Log MAR scale was taken into consideration. Such patients were then subjected to autorefractometry without use of any cycloplegic drugs. A spherical refractive value of ± 1.00 D was considered significant.

RESULTS

Pin-hole testing has a sensitivity of 94.17 percent (95 % CI: 92.61 to 95.48) and specificity of 89.95 percent (95 % CI: 84.75 to 93.84) when compared with autorefractometry finding for identification of refractive errors ($p < 0.0001$). The test has an accuracy level of 93.55 per cent (95 % CI: 92.06 to 94.83).

CONCLUSIONS

The accuracy of pin-hole vision comparison with plain sight in diagnosing refractive errors as the cause of vision loss is reliable enough for it to be used in prompt identification of such cases.

KEY WORDS

Pin-Hole, Refraction, Vision.

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BACKGROUND

Pinholes have been mostly used to confirm whether optical correction by trial frame is optimum or not.[1] Pinhole is based on the principle of allowing a narrow beam of light to focus directly on the macular area of patient's retina, so as visual disturbances caused by refractive errors, or by scattering of light from opacities in the visual pathway other than macula could be eliminated. Also, pinholes can be used to separate visual impairments that can be corrected by optical intervention from those that can't be corrected, i.e., having causes other than refractive error.[2] But very few studies have been performed to test the accuracy and reliability of such use. By establishing a study that is backing the authenticity of pinhole use as a basis of identifying patients with refractive errors, not only can we improve upon our management of refractive errors, but also manage the increasing patient load in a tertiary care setup by early channelling of visual defects with refractive cause to specific treatment using trial glasses.[1]

According to Vision 2020, Refractive errors and low vision has been identified as one of the leading five problems causing blindness around the world.[3] Not only that, but refractive error is an avoidable cause of blindness. It just requires proper identification of such cases and their management; mostly by use of prescription glasses or contacts. Recognising the cause of visual impairment to be refractive error is the foremost step in this. Thus, it requires a rapid method of diagnosing the cause of diminished vision to be refractive error. Use of pinhole is based on the principle that it allows a narrow beam of light to pass through a small hole in an opaque surface, which directly reached the retina without any interference of optical problems of the eye,[4] including refractive errors and media opacities lying anywhere other than visual axis. A 1.2 mm aperture pinhole is commonly used in ophthalmology cases.[5]

Objectives

The objective of this study is to confirm the role of pin-hole based vision in assessment of the cause of vision loss to be refractive error. This can be done by comparing the vision of the patient without any correction in each eye, with the vision after use of pin-hole in the same eye. Meanwhile the contralateral eye is to be occluded.

To prevent further complicating the study group, patients with both eyes functional are to be included in the study.

METHODS

This observational study was conducted from 1st of April, 2019 to 31st of March, 2021; for a period of 2 years at Regional Institute of Ophthalmology, Srirama Chandra Bhanja Medical College and Hospital, Cuttack.

A total of 3572 patients in the age range of 15 to 55 years who visited our tertiary healthcare facility with chief complaints of gradual decrease in vision were introduced to this study. Proper written consent was taken from all the participants. Of them, 2125 patients presented with chief complaints of blurred or diminished or low vision, and had visual acuity of less than 6 / 12 in both eyes. Among them 1286 individuals were selected. Patients with known history of diabetes, hypertension, trauma to eyes, and neurological /psychological complications were excluded from the study. Log MAR chart was used to measure the visual acuity in the selected subjects. Distant vision was recorded in a well-lit room, with a Log MAR chart at a distance of 20 feet from the patient chair. Visual acuity was recorded for individual eyes in each patient; first without, and then with a pin-hole of 1.2 mm diameter. An improvement in vision by at least one Log MAR scale was taken into consideration. Such patients were then subjected to autorefractometry without use of any cycloplegic drugs. After that, subjective refraction was done for each patient using trial frames and lens sets. Refractive errors in the individual eye of each patient were recorded on the basis of spherical equivalent. A spherical refractive equivalent value of ± 1.00 D or more was considered significant for refractive error.

Spherical equivalent refraction (SER) is calculated by adding the spherical component of subjective refractive value with half of the cylindrical value, for each eye separately. In our study, we considered eyes with spherical equivalent refraction of more than ± 1.00 D. Improvement in pinhole was considered in patients with VA less than 6 / 12 when:

1. There was an improvement in vision to 6 / 12 or better on using a pinhole of diameter 1.2 mm.
2. There was an improvement in vision of one Log MAR scale line or more for the individual eye.

Inclusion Criteria

Patients presenting with chief complaint of vision loss, those who can be followed up properly, and have provided proper written consent to be included in this study, after thoroughly being explained about the study and that their data can be shared for research purpose.

The age range of patients to be included in the study was kept between 15 to 55 years.

Exclusion Criteria

Patients with recent history of ocular trauma, painful loss of vision, or sudden onset of vision loss; all of which don't point towards refractive error to be cause of diminished vision.

Also, patients with co morbidities like diabetes mellitus, hypertension, hypercholesterolemia, infectious conditions like tuberculosis, etc. and those with neurological or psychological complications.

Patients who didn't provide consent to be included in this study, are excluded.

Statistical Analysis

All the data was recorded in GraphPad Prism version 7 for Windows. The data collected for visual improvement was compared with the gold standard autorefractometry data used for objective refractive assessment. Sensitivity and specificity of the data was evaluated with a 95% confidence interval.

RESULTS

The age range of 1286 patients selected is tabulated in Table 1. Of the 2572 eyes selected of 1286 individuals, 2104 eyes

responded to pinhole correction, and 2194 eyes responded to subjective correction after autorefractometry (according to the definition of visual improvement taken in this study). The 2 X 2 table for comparison of pinhole data with autorefractometry value is listed in Table 2. The sensitivity of pin holes in detecting refractive errors when compared with autorefractometry is found to be at about 94.2 %. The specificity of the pinhole test in this study is also high, at about 90 %. The significance level of the test is very high [p value < 0.0001]. Along with sensitivity & specificity, the positive and negative predictive values along with their respective 95 % confidence intervals are listed in Table 3.

Age Range (in years)	Presented	Percentage	Corrected	Percentage
Total	**2125**		**1286**	
15 – 30	1029	48.42%	604	46.97%
30 – 45	638	30.02%	390	30.33%
45 – 55	458	21.55%	292	22.71%

Table 1. Age Range

Pinhole / Autorefractometry	Responding	No Response
Responding	2066	38
No response	128	340

Table 2. Comparison of Pinhole Data with Autorefractometry Value

Total eyes responding to pinhole correction: 2104
Total eyes responding to AR correction: 2194

Statistics of This Study	Value	95% CI
Sensitivity	94.17%	92.61% to 95.48%
Specificity	89.95%	84.75% to 93.84%
Positive predictive value	98.19%	97.26% to 98.81%
Negative predictive value	72.65%	67.58% to 77.20%
Accuracy	93.55%	92.06% to 94.83%

Table 3. Comparison of Statistics along with Their Respective 95% Confidence Intervals

DISCUSSION

Table 1 shows that of the total 2125 patients who presented to our tertiary healthcare centre with one of the chief complaints being blurred or diminished or low vision, and had visual acuity of less than 6 / 12 in both eyes in the two-year time period; 1029 patients were in the age range of 15 to 30 years (48.42 %). 638 of those 2125 patients were in the age group of 30 to 45 years (30.02 %), and 458 patients were in the age group of 45 to 55 years (21.55 %). Of these 2125 patients, few were lost to follow up. Out of the remaining patients, 1286 patients were selected at random for complete follow up and study. Of those 1286 patients, the age distribution showed similar variation; with 46.97 % patients (604 patients) in the age group of 15 to 30 years, 30.33 % patients (390 patients) in the age group of 30 to 45 years, and 22.71 % (292 patients) in the age range of 45 to 55 years.

Table 2 compares the patients vision improvement using pinhole versus their vision improvement using autorefractometer. Patients in both the groups were then followed with subjective evaluation using trail frame and trial lens set. Patients were considered as responders when there was an improvement of one log Mar scale value in their corrected visual acuity or final best corrected visual acuity was more than or equal to 6 / 12, done for individual eye. The table lists data on the basis of eyes that responded or didn't respond to the pinhole and autorefractometer.

Table 3 lists the sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of our study along with the respective 95 % confidence intervals of each of the data, as calculated from the data entered in the GraphPad Prism software (version 7 for Windows).

Refractive error is one of the most common avoidable causes of diminished vision. This test signifies the importance of using pinhole as a quick assess tool to identify refractive errors as cause in patients presenting with chief complaint of blurring of vision.[6] As this test has a high sensitivity and specificity when compared with autorefractometry, the accuracy of using pinhole to rule out refractive errors is much significant. Pinhole can be used as a quick assess tool in community screening to check out refractive errors[7] and refer them to higher visual care centres for refractive corrections.

According to a study by Loewenstein et al.[8] use of pinhole disk is highly effective for visual acuity screening, reducing the false-positive rate by more than half. Our study shows in the same line, with a positive predictive value of 98.19 %.

A study conducted by Rajesh S. Kumar et al. (2018)[1] suggested the pinhole occlusion to be a valid gauge of refractive errors in the Rapid Assessment of Avoidable Blindness[6] (RAAB) Survey or other community-based surveys.

CONCLUSIONS

The accuracy of pin-hole vision comparison with plain sight in diagnosing refractive errors as the cause of vision loss is reliable enough for it to be used in prompt identification of such cases.

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