

Original Article

Diagnostic Accuracy of Non-Mydriatic Fundus Camera As A Screening Tool For Diabetic Retinopathy

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Abstract

Objective: To determine the diagnostic accuracy of non-mydriatic fundus camera for the detection of diabetic retinopathy.

Study design: It was a descriptive Cross-Sectional study design.

Place and duration of study: The study was conducted in ophthalmology department of Holy Family Hospital from April 2023 to September 2023.

Material and Methods: The study was started on 1st April 2023. All the patients were referred to the diabetic room of eye OPD of Holy Family Hospital Rawalpindi for the regular checkup for vision. These patients with decreased vision were sample of for current study. The patients having above mentioned anomalies were exposed to diagnostic criteria. Total of 50 patients were sampled for research studies. The data was collected on a Performa specifically designed for research studies. Detailed examination was done of the patient starting from assessment of visual acuity, objective and fundus examination.

Results: The results of studies shown that among of total 50 patients that were selected as sample size, various stages of diabetic retinopathy were observed. Out of 50 patients, NPDR was observed in 10 patients that was 20% of total sampled , PDR in 20 patients (40%) and CSME in 8 patients (16%). 12 of the patients (24%) did not present any diabetic changes upon Fundoscopy. DR was seen to be more common in females (60%) than in males (40%). Upon fundal examination, dull macular reflex was detected in 25 patients (50%). Vitreous hemorrhage was seen in 15 patients (30%).

Conclusion: Fundus camera is an indispensable instrument that facilitates intricate imaging of the posterior portion of the eye, encompassing the retina, optic disc, macula, and blood vessels. A dependable screening method for identifying and referring patients with diabetic retinopathy to an ophthalmologist for additional assessment and treatment is the non-mydriatic fundus camera.

Keywords: Diabetic retinopathy, non-proliferative diabetic retinopathy, proliferative diabetic retinopathy, 90D lens, fundus camera.

1. Introduction

Diabetic Retinopathy is a non-inflammatory disease of the retina, characterized by retinal vascular malfunction that worsens over time as a result of hyperglycemia. Diabetes patients may develop diabetic retinopathy leading to vision loss if not diagnosed and treated in time.¹ The retina is the light-sensitive tissue and damage to its blood vessels is what causes it. Diabetes-related elevated blood sugar levels have the potential to weaken and harm the small blood vessels in the retina over time, which can result in a number of eye issues. The retina is essential to vision because it transforms light into electrical signals that travel to the brain and

enable us to see images. Damage to the retina's blood vessels can result in leaks of blood or fluid or the development of new, aberrant blood vessels. Vision may be significantly impacted by these modifications.

Diabetes-related retinopathy comes in two primary forms:

- Non-proliferative diabetic retinopathy (NPDR): Categories of NPDR are mild, moderate and severe.²

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During the initial phases of the disease, the retina's blood vessels may weaken and grow tiny bulges known as micro aneurysms. These weaker veins have the potential to leak blood or liquid into the retina, which can enlarge the area and impair vision.

- Proliferative diabetic retinopathy (PDR): The retina sustains increasingly severe damage as the condition worsens. The retina may secrete growth factors in reaction to the injured blood vessels, which encourage the formation of new, aberrant blood vessels. Due to their weakness and propensity for leakage, these new blood vessels may cause glaucoma or retinal detachment, as well as cause scar tissue to grow. PDR can cause loss of both central and peripheral vision.³

When diabetic retinopathy first appears, it usually affects both eyes and does not show any symptoms. People may develop symptoms like blurred vision, floaters (small dots or spots in the visual field), poor color vision, black or empty regions in the field of vision, and trouble seeing at night as the illness worsens. Effective management of glucose and blood pressure along with early detection and treatment can reduce vision loss caused by diabetic retinopathy.⁴ An early form of diabetic retinopathy that affects individuals with diabetes is called background diabetic retinopathy or non-proliferative diabetic retinopathy (NPDR). Non-proliferative diabetic retinopathy (NPDR) is a micro vascular complication of diabetes mellitus and may result in permanent visual loss.⁵ It is typified by long-term elevated blood sugar levels that cause damage to the blood vessels in the retina. Controlling diabetes, preserving ideal blood sugar levels, and stopping the condition's progression are the key goals of managing non-proliferative diabetic retinopathy. Regular ocular examinations are necessary to identify and track the development of NPDR, including dilated eye exams.

Pre-proliferative stage is the stage that precedes the proliferative stage of DR. An intermediate stage of diabetic retinopathy known as pre-proliferative diabetic retinopathy (pre-PDR) is marked by more substantial alterations in the retina's blood vessels. It progresses

from non-proliferative diabetic retinopathy (NPDR) and affects people with diabetes. Pre-PDR is characterized by increased blood vessel blockage, which lowers the retina's oxygen and blood flow. The development of weak, new blood vessels that are prone to leaking and bleeding can be the outcome of this condition.

Atypical blood vessel proliferation in the retina is a hallmark of proliferative diabetic retinopathy (PDR), an advanced stage of diabetic retinopathy. Neovascularization of the disc, neovascularization of the retina, neovascularization of the iris, neovascularization of the angle, vitreous hemorrhage or tractional retinal detachment are characteristics of PDR.⁶ If PDR is not addressed, it can be a dangerous disorder that results in severe vision loss. The retina releases growth factors to promote the formation of new blood vessels in reaction to the decreased oxygen and blood flow. But these new vessels are strange, brittle, and prone to leak, which can result in a number of complications. People may have no symptoms at all in the early stages of proliferative diabetic retinopathy. But when the disease worsens, the patient can have impaired vision, floaters, and spots in their vision that are black or empty, or even loss of eyesight. Optical coherence tomography (OCT), fluorescein angiography, and dilated eye exams are among the diagnostic procedures for PDR. Treating problems, sustaining vision and halting the condition's further progression are the primary objectives of proliferative diabetic retinopathy management. Some of the possible treatments for PDR include laser photocoagulation, intravitreal injections, and vitrectomy surgery.

The macula, the core and most sensitive portion of the retina that is in charge of detailed vision, is affected by diabetic maculopathy, commonly referred to as diabetic macular edema (DME), a particular type of diabetic retinopathy. Diabetic retinopathy is one of the main causes of vision loss.⁷ The retina's blood vessels may leak fluid and lipids due to diabetes's elevated blood sugar levels. The risk can be further increased by conditions like pregnancy, specific genetic predispositions, and lifestyle choices like smoking.

Swelling, inflammation, and impaired vision are caused by this buildup of fluid and lipids in the macula, which alters its normal structure and function. Injections of anti-vascular endothelial growth factor (anti-VEGF) are frequently used to manage macular edema and lessen blood vessel leakage. In certain situations, laser photocoagulation therapy—which seals leaky blood arteries using a laser—may also be used.

In ophthalmology, a 90D lens—also referred to as a Volk lens—is an essential instrument. This particular lens provides an enlarged view of the retina, optic nerve, and vitreous fluid, and is mostly used for examinations of the posterior portion of the eye. The term "90D" describes its optical power, which is roughly +90 diopters. Ophthalmologists employ a direct ophthalmoscope or slit lamp in addition to the 90D lens while doing a fundoscopic examination. Numerous eye disorders, including hypertensive retinopathy, diabetic retinopathy, macular degeneration, and retinal detachments, can be diagnosed and tracked with its assistance. Variations and improvements in lens design, such as lenses with larger fields of view or higher magnification, are the result of ongoing technological breakthroughs. With the goal of enhancing patient outcomes, these developments seek to expedite therapeutic procedures and increase diagnostic accuracy.

In ophthalmology, a fundus camera is an indispensable instrument that facilitates intricate imaging of the posterior portion of the eye, encompassing the retina, optic disc, macula, and blood vessels. This tool supports the diagnosis of different eye disorders, tracks the advancement of diseases, and directs medical interventions. Fundus photography produces photos that are used for a variety of purposes. They support the detection and monitoring of conditions affecting the eyes, such as hypertensive retinopathy, glaucoma, macular degeneration, and diabetic retinopathy. In order to manage these disorders and avoid visual loss, early detection is essential.

One typical consequence of diabetes that damages the blood vessels in the retina is diabetic retinopathy.

Fundus photography is a useful tool in DR screening in the primary healthcare settings.⁸ Fundus cameras guide prompt interventions to prevent serious vision damage by helping to detect indications such as micro aneurysms, hemorrhages, and neovascularization. Fundus photography helps with early glaucoma diagnosis and treatment by assessing the optic disc and identifying distinctive alterations.

The diagnostic potential of fundus imaging technology keeps getting better. The introduction of non-mydratic fundus cameras, for example, lessens the requirement for pupil dilation, enhancing patient comfort and making screening in primary care settings easier.

Fundus photography has also been embraced by telemedicine. By using remote image analysis, medical professionals can identify and treat eye diseases in underprivileged communities, improving access to eye care.

To sum up, fundus cameras transform ophthalmic diagnosis and treatment. Their capacity to obtain finely detailed images of the posterior portion of the eye is essential for the early discovery of disease, tracking its advancement, and formulating treatment plans that ultimately preserve vision and enhance patient outcomes.

The results of studies, which was conducted by Mohamed M. Abdelsalam, showed that the suggested methodology could accurately classify patients with non-proliferative diabetic retinopathy and diabetics without DR. Using a supervised artificial neural network with Fiji-based Image-J software and built bespoke programs as a plugin for MATLAB is the foundation of this methodology. With little time required for diagnosis, this method provides high levels of accuracy, resolution, specificity, and precision.⁹

Christopher J. Brady, Samantha L. D'Amico, Brian Y. Kim, and Brittney J. Palermo conducted study in 2022, *Survey of Ophthalmology*, 67 (5), 1531–1539. They conducted a systematic review, searching Central, and applied a bivariate analysis to ascertain the pooled sensitivity and specificity of handheld fundus cameras.

This allowed them to assess the accuracy of commercially available handheld fundus cameras for a range of ocular diseases. Included were eleven studies that compared the performance of handheld fundus cameras to the industry standard for diagnosing diseases.¹⁰

2. Materials & Methods

Descriptive cross-sectional study of 6 months’ duration was conducted from April 2023 to September 2023 involving patients with type 2 diabetes who were examined for diabetic retinopathy was carried out at Holy Family Hospital in Rawalpindi. An optometrist with training acquired a single 45° fundus image focused at the macula and labeled it using a non-mydratic fundus camera. Images were labeled as illegible, negative (no diabetic retinopathy), or positive (diabetic retinopathy present). After that, the ophthalmologist dilated the pupil and used a fundus lens and slit lamp to inspect the fundi. The fundus examination results were classified as invisible/indecisive, negative, or positive. The usual reference for assessing the sensitivity and specificity of non-mydratic fundus camera-based diabetic retinopathy detection was the ophthalmologist’s results. Patients of both genders, Patients of different age groups, Patients representing with hypertension and Diabetes Mellitus and Patients with complain of decrease vision were included in this study. I excluded the Patients who do not cooperate, mentally handicapped patients, Patients not willing to take part.

3. Results

The results of studies showed that among the total 50 patients taken as the sample size, various stages of diabetic retinopathy were seen. Out of sampled 50 patients, 10 patients were observed with NPDR that of (20%) of total sampled patients, PDR in 20 patients (40%) and CSME in 8 patients (16%).¹² of the patients (24%) did not present any diabetic changes upon fundoscopy. DR was seen to be more common in females (60%) than in males (40%). Upon fundal examination, dull macular reflex was observed in 25

patients (50%). Vitreous hemorrhage was seen in 15 patients (30%).

When it comes to diagnosing DR, the non-mydratic fundus camera has a good sensitivity and specificity. It is a very useful and easy-to-use screening tool. However, 90D lens was considered to be more accurate as it gave more detailed fundal picture than the non-mydratic fundal camera.

Table.1. Visual acuity wise distribution

Visual acuity	Number of patients
6\6-6\18	10
6\18-6\60	20
6\60-3\60	15
<3\60	5

4. Discussion

Hyperglycemia-induced retinal vascular dysfunction deteriorates with time, causing a non-inflammatory disease of the retina termed as diabetic retinopathy. Diabetic retinopathy is a potentially deadly condition that affects the eyes that can occur in people with diabetes.

The study reveals the various types of DR, the age group they’re most commonly presented in, the distinctive fundal changes and the effectiveness of the non-mydratic fundal camera.

Research studies shown that the various types of DR observed within the given sample size are NPDR, PDR and CSME. The frequency of these types among the total 50 patients was as follows: NPDR 10 (20%), PDR 20 (40%) and CSME 8 (16%). PDR came out to be the most common type of DR observed within the given sample size.

The sample size included patients from different age groups. 51-60 years was seen to be the most common age group, presented with DR, with 22 patients (44%). Out of the 50 patients with DR, only 13 patients (26%)

belonged to the age group 40-50 years. Number of patients presented with DR in the age group 61-70 years were 15 (30%). On the basis of gender wise distribution, DR was seen to be more common in females (30; 60%) than in males (20; 40%).

During this research, 12 patients with the complaint of decreased vision and risk factors prone to DR were also examined with the fundal camera but no fundal changes were observed.

The research also revealed that upon fundal examination, 25 patients (50%) out of the total 50 patients has shown dull macular reflex, normal retina and dot blot hemorrhages. Vitreous hemorrhage and dull foveal reflex were observed in 10 patients (20%). 15 of the patients (30%) revealed cotton wool spots and hard exudates upon fundal examination. Visual acuity of patients with diabetic retinopathy mentioned in table.1. Examination with 90 D lens showed the whereabouts of cotton wool spots and shape and size of the hemorrhages. According to research, 90 D lens proved to be more accurate than the non-mydratic fundal camera.

Conclusion:

When screening for DR, the non-mydratic fundal camera has a high level of sensitivity and specificity. It is an excellent, user-friendly screening tool. It helps identify conditions that pose a risk to vision and require immediate referral.

Conflict of Interest:

Authors declared no conflict of interest.

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