Original Article

Use of B-Scan Ultrasonography is Determining the Causes of Low Vision in Patients with Diabetic Retinopathy

Salma Liaqat, Jan Zada and Sher Akbar Khan

ABSTRACT

Objective: The objective of this study is to examine the cause of poor vision in individuals diagnosed with diabetic retinopathy (DR) by the application of B-scan ultrasonography.

Study Design: A prospective study

Place and Duration of Study: This study was conducted at the Department of Opththalmology, Saidu Group of Teaching Hospitals, Swat from August 2022 to August 2023.

Methods: One hundred participants with varying degrees of diabetic retinopathy (DR) were prospectively included in the study. Diabetic patients with poor vision were evaluated using a Nidek ultrasound device to identify the underlying reasons based on their HbA1c as well as ETDRS levels.

Results: In the study of 100 diabetes patients, the main statistics revealed an age range of 14 to 69 years, with 85% males and 15% females. Diabetic retinopathy severity increased with age, diabetes duration, and HbA1c levels. Ultrasound exhibited high sensitivity (97.55%) and specificity (83.61%) in detecting diabetic-related low vision causes, emphasizing its diagnostic significance.

Conclusions: The utilization of B-mode ultrasonography in ophthalmology has proven to be a valuable imaging modality for the identification and assessment of difficulties associated with diabetic retinopathy (DR), which can serve as prognostic indicators for visual outcomes. This approach is characterized by its expeditiousness and noninvasive nature, ensuring little pain for patients during the examination.

Key Words: Low vision, Diabetic retinopathy and B-scan ultrasonography

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INTRODUCTION

When a person has visual problems that cannot be fixed with medication, surgery or standard glasses/contacts, they are considered to have low vision. Thus, low vision encompasses a broad spectrum of visual impairment between fully functional eyesight and complete darkness[1]. An individual with low eyesight has an uncorrected distance vision of 3/60 or worse in their better eye.[2,3] Individuals with low vision have an optical acuity of fewer than 6/18 to light perception or an eye field below 10° from the point of fixation despite using or potentially using vision for the proposing of tasks for which vision is crucial Worldwide and especially in the Khyber Pakhtunkhwa area, the incidence of vision impairment and blindness caused by diabetic retinopathy (DR) and other diabetic eye problems is rising.[4] A growing elderly diabetic population and inadequate early tracing methods for diabetics at risk of blindness problems which makes a serious public health concern in poor nations. In 1991, researcher believed that diabetic retinopathy incidence in Swat was roughly 17.2 percent.[2]

diabetic retinopathy, preretinal or vitreous haemorrhage (VH), macular edoema, neovascular glaucoma and capillary nonperfusion are all causes of low vision in diabetic retinopathy patients.[5] Malfunctions, Long-term harm failure of several organs such as the heart, eyes, kidney and blood vessels related to the chronic hyperglycemia of diabetes.[6] Polyuria, weight loss, polydipsia and impaired eyesight are all symptoms of severe hyperglycemia. Chronic hyperglycemia has been linked to growth retardation and an increased risk of infection. 6 proliferative retinopathy (PR), Minimal, mild, moderate and severe nonproliferative retinopathy (NPDR) were the ETDRS classifications used to categorise diabetic retinopathy status. Based on stereoscopic fundus examination with a 90-diopter lens, the ETDRS has adopted the modified Airlie House categorization of diabetic retinopathy.[7]

B-scan ultrasonography is a diagnostic technique that has demonstrated use in the assessment of diabetic

[1.] Department of Ophthalmology, Saidu Medical College and Saidu Teaching Hospital, Swat.

Correspondence: Sher Akbar Khan, Associate Professor Ophthalmology, Saidu Medical College and Saidu Teaching Hospital, Swat.
Contact No: 0333-9346461
Email: urhumbleme@yahoo.com

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retinopathy. B-scan ultrasonography is a medical imaging technique that generates an ocular picture by employing high-frequency sound waves sent from a transducer towards the tissue of interest.[10] These sound waves then reflect to the transducer with changing durations and amplitudes. The aforementioned data are further analysed and combined in order to provide a 2D model of the eye.[8] However, its utility is most pronounced in individuals with VH or other forms of media opacity. The presence of a RD may be demonstrated by this technique, along with the ability to detect additional retinal pathologies such as VH or posterior vitreous detachment (PVD).[9] The concentration of healthcare facilities, private clinics, and specialists in KPK is mostly observed in Swat, where around 70% of eye care services are located.[14] Regrettably, there is a lack of relevant information regarding the risk variables and prevalence of diabetic retinopathy in the community. Hence, the major objective of this study was to investigate the aetiology of visual impairment in individuals diagnosed with diabetic retinopathy by the application of B-scan ultrasonography.

METHODS

The Ultrasound Department at Saidu Group of Teaching Hospitals, Swat, conducted this prospective research from August 2022 to August 2023. A cohort of 100 DR patients at various stages was studied. A complete physical examination was performed on all patients before ultrasonic scanning. This exam includes slit lamp, visual acuity, intra-ocular pressure, pupillary response, fundoscopy, biomicroscopy, and tonometry. Clinical and retinography tests diagnosed DR. Participants had to be Swat citizens, live in the country, be male or female, be of various ages and ethnicities, and have any form of diabetes mellitus (DM) (confirmed by two fasting serum glucose levels above 126 mg/dL). Patients having hypertension or ocular hypertension above 20 mm Hg, ocular surgery, afferent pupillary conduction anomalies, or insulin treatment were excluded from the research. The study included type 2 diabetics without proliferative diabetic retinopathy, hypertension, or insulin treatment.

B-Scan Ultrasonography Examination:

Patients were positioned supine for sonographic tests in a room with controlled temperature (26 °C; 78 °F). A diagnostic B-mode scan was performed using a Nidek ultrasonic equipment with a 10 MHz direct contact transducer. The technology used 400 lines of sampling over a 60° field of view to create high-resolution images. A touchscreen panel with a 1024x768 resolution and thermal printer displayed these pictures. To ensure a thorough ultrasonography examination, the initial tests used high gain (80-90dB) and low gain (60-70dB) sensitivity levels. The technology automates temporal gain correction and dynamic range control of ultrasound echo signals to improve ultrasound pictures. Time gain compensation (TGC) compensates for signal strength loss at various depths. This correction ensures visual quality throughout depth. Dynamic range adjustment (DRA) controls picture contrast resolution. Adjusting the dynamic range improves echo amplitude differentiation between neighboring structures.

The patient received local anesthetic using Minims Tetracaine Hydrochloride (0.5%) w/v eye drops and Aquasonic 100 Ultrasound Gel as the coupling agent. B-scan imaging was done supine, using transverse probe orientation to visualize lateral illness extent through a limbus-related area of interest. Radial extent was measured using longitudinal probes perpendicular to the limbus and aimed towards the region of interest. During the surgery, optic nerve shadows and the posterior pole were crucial reference points.

Data Collection: The data collection for this prospective study took place at the Ultrasound Department of Saidu Group of Teaching Hospitals in Swat, covering the period from September 2022 to September 2023. The study encompassed a cohort of 100 individuals who had been diagnosed with diabetic retinopathy (DR) at various stages.

Statistical Analysis: Data were tabulated and shown graphically, with results reported as mean standard deviation (SD). Patients with moderate, mild, severe NPDR and PR were analysed to determine the range, mean, and SD for age, duration of DM, and HbA1c values. Diabetic patients with impaired vision were analysed using statistical diagnostic methods to establish the sensitivity and specificity of B-scan ultrasonography. SPSS version 20 for Windows was used for the statistical analysis.

RESULTS

In this prospective investigation, 100 individuals with diagnosed diabetes (200 eyes) underwent a comprehensive physical examination in addition to a B-scan ultrasonography. There were 85% male patients and 15% female patients making a ratio of 3:1. Ages ranged from 14 to 69, as shown in Table 1. Forty-one percent of the male population was comprised of 35 individuals between the ages of 47 and 57.

Table No.1: Age distribution among DM patients

Age ranges	Frequency (n); percentage of age ranges in male patients	Frequency (n); percentage of age ranges in female patients
14–24	7 (8.2%)	1 (6.7%)
25–35	13 (15.3%)	2 (13.3%)
36–46	15 (17.6%)	2 (13.3%)
47–57	35(41.2%)	5 (33.3%)
58–68	15(17.6%)	5 (33.3%)
Total	85(100%)	15(100%)

Table 1 shows that just 8.2% of the population was comprised of people aged 14–25. There were 5 female patients in the age range of 47 to 57, or 33.3% of the total female population. Table 1 shows that the population share of those aged 14–25 is the lowest (4%).

Table No.2: Grading of DR status in the eyes of diabetic patients.

Variables	Minimal NPDR	Mild NPDR	Moderate NPDR	Severe NPDR	PR
Numbers in the sample	30	33	22	12	3
Mean age ± SD (years)	24 ± 0.6	42 ± 1.3	56 ± 1.9	60 ± 1.2	68 ± 1.8
Duration of DM	15 ± 1.4	18 ± 1.7	21 ± 1.6	24 ± 2.1	26 ± 2.4
HbA1c (%)	9.55 ± 1.4	10.05 ± 2.1	10.4 ± 0.2	11.9 ± 0.7	11.9 ± 1.1
Male-Female (in the sample)	23–5	25–5	15–1	12–2	10–1

True positive findings were found in 93% of the cases studied, demonstrating that ultrasonography successfully identified the underlying causes of visual impairment in these patients. In addition, as demonstrated by the 13 false negatives, the test successfully identified cases in which diabetic retinopathy was not the source of visual impairment. In addition, two individuals had false negative results, meaning that ultrasonography was unable to detect the causes of their diabetes. A positive ultrasound test was a strong predictor of diabetic-related reasons for impaired vision, with a positive likelihood ratio of 7% and a CI of 1.93 to 25.99. In contrast, a negative ultrasonography test clearly showed the lack of diabetic-related reasons, since the negative probability ratio was very low at 0.02, with a CI from 0.01 to 0.07. When ultrasonography findings were negative, a substantial chance that diabetic-related reasons were missing was identified (90.31% NPV, CI, 61.80%-97.74%). In contrast, when the ultrasonography results were positive, the PPV was 98.92% with a CI from 92.89% to 98.51%, demonstrating the high possibility that diabetic-related causes were present.

Table No.3: Performance of ultrasound in detection of the reasons of low sight in diabetic patients.

Causes of low vision	Number of cases
True positive	93
True negative	13
False positive	1
False negative	2

performance of ultrasound	Value	(95%) CI
Specificity (%)	(83.61%)	(55.19% to 97.22%)
Sensitivity (%)	(97.55%)	(95.27% to 98.97%)
Disease prevalence (%)	(85.16%)	(76.39% to 93.80%)
Positive likelihood ratio	7%	1.93 to 25.99
Negative likelihood ratio	0.02	0.01 to 0.07
NPV (%)	(90.31%)	(61.80% to 97.74%)
PPV (%)	(98.92%)	(92.89% to 98.51%)

DISCUSSION

B-scan ultrasonography is particularly valuable in diabetic patients who exhibit VH or other forms of media opsacities, as these conditions hinder direct visualisation of the retina during examination. B-scan ultrasonography can detect the presence of RD and can also reveal other retinal pathologies, such as VH or PVD.[11] The present study aimed to identify the factors contributing to decreased visual acuity in individuals diagnosed with DM across various age groups (ranging from 14 to 69 years). The findings, which are summarised in Tables 1, 2, and 3, provide insights into the relationship between the severity of diabetic retinopathy as measured by the ETDRS severity scale. The present study shows that diabetic individuals with poorly controlled HbA1c levels have several diseases in their eyes compared to those with moderately controlled HbA1c levels.

Patients with diabetes often have visual impairment due to tissue hypoxia. It is likely that an increase in vascular endothelial growth is also a crucial angiogenic component in the pathophysiology of diabetic retinopathy. Retinal haemorrhage and edoema, as well as the appearance of macular edoema, are caused by the microangiopathy and capillary occlusion, which combined cause microvascular leakage and collapse of the blood-retinal barrier.[12,13] Patients with impaired autoregulatory responses to changes in oxygen levels or medicines suffer from abnormal ocular vascular function.[12] According to our study's ultrasound results, the most common types of ocular abnormalities among diabetes patients were VH, RD, AH, CD and PVD.

This study's causes of low vision could be compared to those found in a study on sonographic ocular findings in diabetic retinopathy, where ocular sonography was found to be a "very useful diagnostic tool in detection and evaluation of diabetic retinopathy complications,"

as it "shows the nature and extent of lesions in eyes with vitreous opacification, which is usually not visualised on ophthalmoscopy, helping to determine the clinical treatment or timing of surgery, and to predict the visual outcome.

This research is constrained by the fact that the randomised selection process produced a demographically heterogeneous sample (in terms of age, gender, and race), which could potentially compromise the reliability of the diabetic retinopathy's effect on our measurement parameters and, consequently, significantly weaken the force of our conclusions. Despite its likely small size due to its population-based design, the current study is important because it is one of the recent studies that uses ophthalmic B-scan ultrasonography to determine the causes of low vision among diabetic patients with diabetic retinopathy.[14]

CONCLUSION

In conclusion, this prospective study elucidates the myriad difficulties presented by impaired vision in the diabetic population, with a special emphasis on diabetic retinopathy and its diagnostic evaluation through B-scan ultrasonography. The wide age range of the research sample, which was skewed toward males, exemplifies how diabetes affects people in many walks of life. A comprehensive evaluation of diabetic retinopathy severity showed a clear connection between retinopathy severity, patient age, and diabetes duration. More severe ocular symptoms were related with poorly managed HbA1c levels, highlighting the vital necessity of glycemic control in the management of diabetic eye problems. In circumstances when media opacity prevented direct retinal inspection, B-scan ultrasonography was crucial in detecting diabetic retinopathy-related causes of impaired vision. Ultrasound's very high sensitivity and specificity bolster its relevance as a non-invasive diagnostic technique in diabetic eye care.

The demographic diversity of the study's participants may add some variation into the reported effects of diabetic retinopathy on visual impairment, so it's important to keep that in mind. However, there is a lack of data on risk factors and the prevalence of diabetic retinopathy in the context of diabetic eye care, therefore this study is an important addition. In conclusion, the importance of early identification of diabetic retinopathy and adequate glycemic management in reducing the prevalence of impaired vision among people with diabetes is highlighted by this study. As a bonus, it shows how important B-scan ultrasonography is for diagnosing ocular problems and making clinical decisions. More work has to be done to improve risk classification, examine differences between the sexes, and assess the lasting effects of various therapies on patients' ability to see diabetic retinopathy.

Limitation and Recommendations for future studies

This study, conducted at a single healthcare center with a relatively small sample size skewed towards males, may limit the generalizability of its findings and statistical power. Selection bias stemming from the exclusion of patients with hypertension or ocular hypertension, as well as the demographic heterogeneity of the sample, raises concerns about the representation of the wider population. Future research should prioritize large-scale multicenter studies with diverse samples to enhance generalizability and statistical power. Patient-centered research can uncover the lived experiences of individuals with diabetic retinopathy-related visual impairment, guiding patient-centered care models.

Author's Contribution:

Concept & Design of Study:	Salma Liaqat
Drafting:	Jan Zada
Data Analysis:	Sher Akbar Khan
Revisiting Critically:	Salma Liaqat, Jan Zada
Final Approval of version:	Salma Liaqat

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