Utilization of Ophthalmic B-scan Ultrasonography to Identify the Etiology of Impaired Vision in Diabetic Retinopathy Patients

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Introduction

❑ Low vision, from normal to no light perception, cannot be corrected by treatment or conventional lenses. Diabetic retinopathy (DR), a leading cause of low vision and blindness, is increasingly prevalent in Sudan (Fig. 1).[1–3]

❑ Recent studies report DR in 82.6% of diabetics in Khartoum and 33% of type 1 adolescents, causing vision loss via detachment, hemorrhage, and macular edema. The Early Treatment Diabetic Retinopathy Study (ETDRS) grades severity, and B-scan ultrasonography detects proliferative diabetic retinopathy (DR).[1–3]
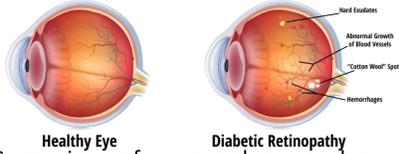

Fig 1. Comparison of a normal eye and an eye with diabetic retinopathy.[1]

Aim

❑ In Sudan, most eye care services are in Khartoum State[1,2], yet limited data exist on DR prevalence and risk factors. This study examines low vision causes in Sudanese DR patients using ophthalmic B-scan ultrasonography to improve clinical management.

Methods

❑ In this prospective study, 100 Sudanese patients with various grades of DR were recruited at Makkah Eye Hospital, Khartoum, between September 2020 and January 2023, with ethics approval. All underwent ophthalmologic exams including visual acuity, slit lamp, fundoscopy, and retinography. Inclusion criteria were Sudanese nationality, confirmed diabetes, no hypertension, and no ocular disease or insulin treatment.

❑ B-scan ultrasonography was performed with patients supine using a Nidek Echoscan US-4000 (10 MHz) with 0.5% Tetracaine and ultrasound gel. The sonographer adjusted gain, time gain compensation, and dynamic range, performing transverse and longitudinal scans with probe orientation and patient gaze directed to the target. Posterior pathologies were centered for optimal resolution, and images were documented (Fig. 2).[4]

Fig 2. Ocular B-scan with a longitudinal probe, positioned perpendicular to the limbus or target area of interest.[4]

Methods

❑ Eye ultrasonography safety was ensured by using low initial power, minimizing exposure time, avoiding prolonged probe contact, and reviewing images with freeze-frame or cine-loop to reduce thermal and non-thermal risks.[4]

❑ Data were summarized as mean ± SD, and SPSS (version 20) was used to analyze age, DM duration, Hemoglobin A1c (HbA1c), and B-scan sensitivity and specificity.

Results

❑ In this study, 100 diabetic patients (200 eyes) underwent ophthalmologic and B-scan exams. Seventy-five percent were males, 25% females, with a mean age of 46.4 ± 1.4 years (14–79). The largest age group was 47–57 years, and the smallest 14–24 years.

❑ According to ETDRS grading, most patients (34%) had mild nonproliferative retinopathy (NPDR), with HbA1c levels ranging from 9.55 ± 1.7 to 11.9 ± 1.1, indicating moderate to poor glycemic control. Distribution of NPDR was also analyzed by age, gender, duration of diabetes, and ethnicity.

❑ Ophthalmic ultrasound showed that vitreous hemorrhage 57 (57%), retinal detachment 21 (partial 9, total 12), posterior vitreous detachment 7 (7%), asteroid hyalosis 12 (12%), and choroidal detachment 3 (3%) were the main causes of low vision among Sudanese patients with diabetic retinopathy (Fig. 3 & Fig. 4).
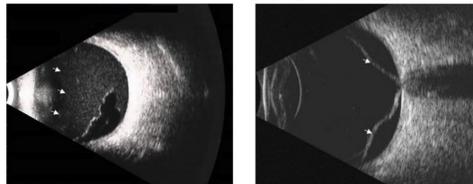

Fig 3. Axial B-mode ophthalmic ultrasound shows fresh vitreous hemorrhage in a 20-year-old male (*left, arrows*) and partial retinal detachment in a 39-year-old female (*right, arrows*).

❑ Moderately regulated HbA1c with mild NPDR caused low vision mainly from vitreous hemorrhage 42 (66.6%) and partial retinal detachment 9 (19%), while poorly regulated HbA1c with advanced NPDR or proliferative retinopathy involved vitreous hemorrhage 15 (40.5%) and total retinal detachment 12 (32.4%).
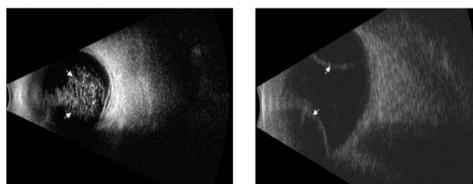

Fig 4. Axial ophthalmic ultrasound shows vitreous hyper-echogenic foci with asteroid hyalosis in a 25-year-old female (*left, arrows*) and choroidal detachment in a 30-year-old male (*right, arrows*).

Results

❑ Ophthalmic ultrasound showed a sensitivity of 98.95% (95% confidence interval: 94.27%–99.97%), specificity of 85.71% (95% confidence interval: 57.19%–98.22%), a positive predictive value (PPV) of 97.92%, and a negative predictive value (NPV) of 92.31% for detecting causes of low vision in diabetic patients (Table 1).

Table 1. Performance of ophthalmic ultrasound in detecting causes of low vision in diabetic patients.

Performance of Ophthalmic Ultrasound Imaging	Value	(95%) CI
Sensitivity (%)	(98.95%)	(94.27% to 99.97%)
Specificity (%)	(85.71%)	(57.19% to 98.22%)
Positive likelihood ratio	6.93	1.92 to 24.99
Negative likelihood ratio	0.01	0.00 to 0.09
Disease prevalence (%)	(87.16%)	(79.39% to 92.80%)
PPV (%)	(97.92%)	(92.87% to 99.41%)
NPV (%)	(92.31%)	(62.80% to 98.84%)

Discussion

❑ Ophthalmic B-scan ultrasonography detects retinal and vitreous pathologies in diabetic patients, with severity linked to HbA1c levels and nonproliferative retinopathy (NPDR) stage.[5]

❑ Tissue hypoxia and vascular changes in diabetes cause retinal damage, leading to vitreous hemorrhage, retinal detachment, posterior vitreous detachment, and choroidal detachment.[6]

❑ Ophthalmic ultrasound effectively detects diabetic retinopathy complications, guiding treatment and predicting outcomes, with high sensitivity, specificity, PPV, and NPV, consistent with prior studies.[7]

❑ Most Sudanese diabetic patients in this study were from the Central region, with prevalent low vision causes—matching a Khartoum report of 82.6% diabetic retinopathy.[2,3] Despite demographic gaps, it provides updated data via ophthalmic B-scan.

Conclusions

❑ In conclusion, early detection and treatment are crucial to prevent diabetic vision loss. Ophthalmic B-mode ultrasound is a noninvasive tool that evaluates retinopathy complications, visualizes lesions despite vitreous opacities, and aids treatment planning and outcome prediction.

Funding

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