European Journal of Radiology Open 5 (2018) 79–86

Contents lists available at ScienceDirect

European Journal of Radiology Open

journal homepage: www.elsevier.com/locate/ejro

Use of ophthalmic B-scan ultrasonography in determining the causes of low vision in patients with diabetic retinopathy

Ibrahim E. Mohamed[a], Mona A. Mohamed[a], Mohamed Yousef[b], Mustafa Z. Mahmoud[c,*], Batil Alonazi[c]

[a] Department of Diagnostic Radiologic Technology, College of Medical Radiological Sciences, Sudan University of Science and Technology, Khartoum, Sudan
[b] Radiologic Sciences Program, Batterjee Medical College, Jeddah, Saudi Arabia
[c] Radiology and Medical Imaging Department, College of Applied Medical Sciences, Prince Sattam bin Abdulaziz University, Al-Kharj, Saudi Arabia

ARTICLE INFO

Keywords:
Diabetic retinopathy
Low vision
Ophthalmic B-scan ultrasonography

ABSTRACT

Purpose: To determine the causes of low vision among Sudanese patients with diabetic retinopathy (DR) by using ophthalmic B-scan ultrasonography.

Materials and methods: A total of 100 patients with DR at different grades, were recruited prospectively between September 2016 and January 2018. Nidek (Echoscan US-4000) ultrasound unit was used to determine the causes of low vision in diabetic patients according to their glycated haemoglobin (HbA1c) and early treatment of diabetic retinopathy scale (ETDRS) severity levels.

Results: Vitreous hemorrhage (VH) 42(66.6%), asteroid hyalosis (AH) 12(14.3%), and partial retinal detachment (PRD) 9(19%) were the main cause of low vision in patients presenting with moderately regulated HbA1c and graded with either minimal or mild nonproliferative retinopathy (NPDR). While VH 15(40.5%), total retinal detachment (TRD) 12(32.4%), posterior vitreous detachment (PVD) 7(19%), and choroidal detachment (CD) 3(8.1%), were dominant in patients with poorly regulated HbA1c and graded either as moderate NPDR; severe NPDR; and proliferative retinopathy (PR).

Conclusions: Ophthalmic B-mode ultrasound is a rapid, noninvasive imaging technique that can be used with minimum discomfort in ophthalmological practice for the detection and evaluation of DR complications that predict the visual outcome.

1. Introduction

The term low vision describes vision disorders that cannot be corrected with medical treatment, surgical interference, or conventional eyeglasses or contact lenses. Hence, low vision refers to a wide range of vision reduction between normal vision and no light perception [1]. Low vision is visual acuity less than 6/18 and equal to or better than 3/60 in the better eye with best correction. A person with low vision is one who has an impairment of visual functioning even after treatment and/or standard refractive correction, and has a visual acuity of less than 6/18 to light perception, or a visual field less than 10 degrees from the point of fixation, but who uses, or is potentially able to use, vision for the planning and/or execution of a task for which vision is essential [2].

The prevalence of visual impairment and blindness due to diabetic retinopathy (DR) and diabetic eye complications is on the rise worldwide and more specifically in North Africa and the Middle East region. While in developing countries, it's a major public health problem in diabetics, mainly due to an increase in the number of older diabetics and the insufficiency of early tracing routines of diabetics at risk of blinding complications [3]. The prevalence of DR in Sudan was estimated to be around (17.2%) in 1991 [4]. Another study carried in out patient of 3 general hospitals in Khartoum, Sudan in 1995 for insulin-treated diabetic patients revealed that the prevalence of DR was (43%), nephropathy was (22%) and neuropathy was (37%) [5].

Low vision due to DR occurs through a variety of mechanisms, including retinal detachment (RD), preretinal or vitreous hemorrhage (VH), associated neovascular glaucoma, and macular edema or capillary nonperfusion. The chronic hyperglycemia of diabetes is associated with long-term damage, dysfunction and failure of different organs, especially the eyes, kidneys, nerves, heart, and blood vessels. Symptoms of marked hyperglycemia include polyuria, polydipsia, weight loss, sometimes with polyphagia, and blurred vision. Impairment of growth and susceptibility to certain infections may also accompany with

* Corresponding author at: Radiology and Medical Imaging Department, College of Applied Medical Sciences, Prince Sattam bin Abdulaziz University, PO Box 422, Al-Kharj, 11942, Saudi Arabia.
E-mail address: m.alhassen@psau.edu.sa (M.Z. Mahmoud).

https://doi.org/10.1016/j.ejro.2018.05.002
Received 22 February 2018; Received in revised form 23 April 2018; Accepted 2 May 2018

Table 1
Abbreviated summary of the final version of the early treatment diabetes retinopathy study scale of DR severity for individual eyes [12].

Level	Severity	Definition
10	No retinopathy	DR absent
20	Very mild NPDR	Microaneurysms only
35	Mild NPDR	Microaneurysms plus hard exudates, soft exudates (cotton-wool spots) and/or mild retinal hemorrhages
43	Moderate NPDR	Microaneurysms plus mild IRMA* or moderate retinal hemorrhages
47	Moderate NPDR	More extensive IRMA. Severe retinal hemorrhages, or venous beading in one quadrant only
53	Severe NPDR	Severe retinal hemorrhages in 4 quadrants, or venous beading in at least 2 quadrants, or moderately severe IRMA in at least 1 quadrant
61	Mild PDR	NVE* < 1/2 disc area In 1 or more quadrants
65	Moderate PDR	NVE* ≥1/2 disc area In 1 or more quadrants, or NVD* < 1/4–1/3 disc area
71–75	High-risk PDR	NVD* ≥1/4–1/3 disc area and/or VH
81–85	Advanced PDR	Fundus partially obscured

* IRMA: Intraretinal Microvascular Abnormalities; NVE: New Vessels Elsewhere; NVD: New Vessels on or within 1 Disc Diameter of Optic Disc.

chronic hyperglycemia [6].

DR status was graded using the early treatment of diabetic retinopathy scale (ETDRS) on the basis of the ETDRS severity level as: minimal nonproliferative retinopathy (minimal NPDR), mild nonproliferative retinopathy (mild NPDR), moderate nonproliferative retinopathy (moderate NPDR), severe nonproliferative retinopathy (severe NPDR), and proliferative retinopathy (PR). The modified Airlie House classification of DR has been extended for use in the ETDRS on the basis of stereoscopic fundus examination with a 90 diopter lens [7–9]. Also, the glycated haemoglobin (HbA1c) levels of the diabetic eyes were separated into three distinct groups: well regulated (6.1–8%), moderately regulated (8.1-10%) and (≥10.1%) as poorly regulated [10,11]. Abbreviated summary of the ETDRS final scale of DR severity for individual eyes is presented in Table 1 [12].

Ophthalmic B-scan ultrasonography is an imaging modality that can be useful in proliferative diabetic retinopathy (PDR). B-scan ultrasonography creates an image of the eye by using sound waves transmitted at a high frequency from a transducer to the target tissue, which then return to the transducer at varying times and amplitudes. These signals are then interpreted and summed to construct a two-dimensional (2D) image of the eye [13]. While it is most useful in patients with VH or other media opacity. It can demonstrate if a RD is present and can show other retinal pathology such as a VH or posterior vitreous detachment (PVD) [14].

In Sudan, it was noticed that most hospitals, private clinics and specialists are concentrated in Khartoum State, where approximately (70%) of eye care is found [1]. Unfortunately, limited information is available about the risk factors and frequency of DR in Sudanese population. Therefore, this study was designed with an aim to determine the causes of low vision among Sudanese patients with DR by using ophthalmic B-scan ultrasonography.

2. Materials and methods

2.1. Selection and description of patients

After receiving approval from the local ethics committee, a group of 100 patients with DR at different grades, presenting at the ultrasound clinic, Makkah Eye Hospital, Khartoum, Sudan, were recruited between September 2016 and January 2018 in this prospective study. A waiver of informed consent was granted in accordance with institutional guidelines.

Before starting the ophthalmic ultrasound scanning, all patients underwent standard physical and ophthalmologic examinations. Were a detailed history and complete preoperative eye examination protocol, including slit lamp examination, visual acuity tests, intra-ocular pressure, pupillary reaction, biomicroscopy, fundoscopy, and tonometry were done. The diagnostic of DR was based on the clinical and retinography examinations performed. In addition, to ensure the credibility of the obtained results, a very strict inclusion criteria were followed, which were the existence of one of the following conditions in patients: Sudanese nationality, area of location in Sudan, gender difference either male or females, ages and ethnicities, patients with any type of diabetes mellitus (DM) (fasting serum glucose > 126 mg/dL on two independent determinations), with no hypertension or ocular hypertension (> 20 mm Hg), no previous history of ocular trauma or ocular surgery at any time or afferent pupillary conduction defect, and not undergoing insulin treatment. Also, patients with type 2 DM with no proliferative DR or hypertension and not undergoing insulin treatment were included in the study.

2.2. Ophthalmic B-scan ultrasonography examination

All sonographic examinations were performed in a supine position in a thermally controlled room of (26 °C; 78 °F) by the same sonographer. The diagnostic B-mode was performed using a Nidek (Echoscan US-4000) ultrasonic unit, equipped with a high frequency direct contact 10 MHz transducer. It allows high-resolution images from 400 lines of sampling over 60°, displayed on the 1024 × 768 extended graphics array/adaptor (XGA) touch screen monitor with built-in thermal printer. Initial examination was performed under high gain (80 dB to 90 dB) and low gain (60 dB to 70 dB) sensitivity for more detailed inspection during ultrasonography.

For efficient and accurate diagnosis of ultrasound images, the appropriate time gain compensation and dynamic range control of ultrasound echo signals were automatically set by the system and/or manually adjusted by the sonographer to obtain the desired image quality on the screen. Time gain compensation was used for compensating the attenuation of ultrasound echo signals along the depth, and the dynamic range adjusted was for controlling the image contrast resolution, i.e., To increase the ability to distinguish between different echo amplitudes of adjacent structures.

Minims Tetracaine Hydrochloride (0.5%) w/v, eye drops solution was used for local anesthesia and Aquasonic 100 Ultrasound Gel was applied as the coupling material. B-scans were performed with the patient lies in the supine position. The transverse probe position (Fig. 1) was used to demonstrate the lateral extent of the pathology. With the eye anesthetized, the patient was instructed to look in the direction of the area of interest. The probe face is coated in ultrasound gel and positioned on the opposite conjunctival surface parallel to the limbus, regardless of probe location around the globe, with the marker aimed either superiorly or nasally. Consequently, the marker is oriented superiorly when examining the nasal or temporal globe (3 O'clock or 9 O'clock positions) and toward the nose when examining the superior or inferior globe (12 O'clock or 6 O'clock positions).

B-scans with longitudinal probe positions (Fig. 2) were also used to represent the radial extent. As with transverse scans, the patient is instructed to look in the direction of the area of interest, and the probe face is placed on the opposite conjunctival surface. However, in longitudinal scanning, the probe face is rotated so that it is perpendicular to the limbus, with the marker directed toward the limbus, or to the area of interest, regardless of the clock hour being examined. This results in the optic nerve shadow being represented at the bottom on the right side of each longitudinal echogram, and the posterior pole just above the nerve shadow.

If any posterior pathology is detected during basic screening, it should be centered on the right side of the echogram to achieve greater resolution. This is accomplished by determining the clock hour represented in the center, top, and bottom of the right side on the