

## Sonographic ocular findings in diabetic retinopathy

### Achados ultrassonográficos ocular em retinopatia diabética

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#### Abstract

**Introduction:** Despite recent improvements in ophthalmologic examination techniques, the evaluation of vitreoretinal diseases due to diabetic retinopathy (DR) often presents a diagnostic challenge. Ocular sonography is superior to computed tomography and magnetic resonance imaging in detecting DR, because the eye can be examined dynamically during ocular movements, and can gather a vast amount of information what is not possible with clinical examination alone. **Objective:** Observational study demonstrating ophthalmic ultrasound findings of patients with DR in your different grades. **Methodology:** Study in which are presented the sonographic aspects in a group of patients with DR in your different grades. We studied both eyes of individuals with DR by ocular sonography. The diagnostic of DR was based on the clinical and retinography examinations performed. The DR was classified according to the modified Airlie House system on the basis of stereoscopic fundus examination with a 90 diopter lens. **Results:** The individuals examined had some degree of DR, level 20 to 85 of the Early Treatment of Diabetic Retinopathy Scale. The diagnosis of DR was accomplished when at least four or more microaneurysms were present in the retinography, with or without hard or soft exudates, in the absence of other known diseases, being presented the sonographic features of these complications. **Conclusion:** Ocular sonography is very useful diagnostic tool in detection and evaluation of DR complications, because shows the nature and extent of lesions in eyes with vitreous opacification, which is usually not visualized on ophthalmoscopy, helping to determine the clinical treatment or timing of surgery, and to predict the visual outcome and it may serve as a useful extension of the initial investigation of the symptomatic or not patient. **Keywords:** Diabetic Retinopathy. Diagnosis. Ultrasonography.

#### Resumo

**Introdução:** Apesar das recentes melhorias técnicas do exame oftalmológico, a avaliação de doenças vítreo-retinianas devido à retinopatia diabética (RD) apresenta um desafio diagnóstico. A ultrassonografia ocular é um exame superior à tomografia computadorizada e ressonância magnética na detecção da RD, porque o olho pode ser examinado de forma dinâmica durante os movimentos oculares, além de fornecer informações que não é possível apenas com o exame clínico. **Objetivo:** Estudo observacional demonstrando os achados ultrassonográficos oftalmológicos de pacientes com RD em seus diferentes graus. **Metodologia:** Estudo no qual são apresentados os aspectos ultrassonográficos de um grupo de pacientes com RD em seus diferentes graus. Foram estudados os olhos de indivíduos com RD por ultrassonografia ocular. O diagnóstico da RD foi baseado no exame clínico e na retinografia. A RD foi classificada de acordo com o sistema Airlie House modificado com base no exame estereoscópico com uma lente de 90 dioptria. **Resultados:** Os indivíduos examinados apresentaram algum grau de RD, nível 20 para 85 da Early Treatment of Diabetic Retinopathy Scale. O diagnóstico de RD foi realizado quando, pelo menos, quatro ou mais microaneurismas estavam presentes na retinografia, com ou sem exsudatos duros ou moles, na ausência de outras doenças conhecidas, sendo apresentados os aspectos ultrassonográficos destas complicações. **Conclusão:** A ultrassonografia ocular é uma ferramenta muito útil de diagnóstico na detecção e avaliação das complicações da RD, porque mostra a natureza e extensão das lesões nos olhos com opacificação do vítreo, que normalmente não é visibilizado na oftalmoscopia, auxiliando na determinação do tratamento clínico ou cirúrgico e no prognóstico do resultado visual, além de poder servir como uma extensão da investigação inicial do paciente sintomático ou não. **Palavras-chave:** Retinopatia Diabética. Diagnóstico. Ultrassonografia.

#### INTRODUCTION

Ultrasound in eye exam was first described in 1956 by American ophthalmologists Mundt and Hughes with use of the A-scan and in 1958 Baum demonstrated the

B-scan. Pavlin and colleagues described in 1991, the first high frequency ultrasound (Ultrasound biomicroscopy) in ophthalmology, and currently sonography is considered an essential tool in the investigation and management of many ocular and orbital disorders<sup>1,2</sup>.

Ocular sonography is an important adjuvant for the clinical assessment of various ocular, and

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can gather a vast amount of information what is not possible with clinical examination alone. Furthermore, is used for the investigation of extraocular muscles and retrobulbar optic nerve, and can also be used to confirm ophthalmoscopic findings, such as retinal detachment or cataractous<sup>3</sup>.

Despite recent improvements in ophthalmologic examination techniques, the evaluation of vitreoretinal alterations due diabetic retinopathy (DR) often presents a diagnostic challenge. Ocular sonography is superior to computed tomography and magnetic resonance imaging in detecting of DR, because the eye can be examined dynamically during ocular movements and the ocular ultrasound provides eye images with higher resolution. The importance of ultrasound scanning of eyes with DR in eyes with opaque media is established clearly<sup>4</sup>.

The DR is a common cause of blindness, visual loss resulting from macular edema, vitreous hemorrhage, retinal detachment. In the proliferative DR new blood vessels develops as a response to retinal ischaemia, and as a consequence occurs fibrous contraction within the epiretinal membrane and consequent tangential traction on the retina; an exaggerated adhesion between the vitreous gel and the retina owing to incarceration of cortical gel in the vascularised epiretinal membrane, and finally incomplete posterior vitreous detachment<sup>5</sup>. Acute loss of vision can occur when new blood vessels rupture and bleed into the vitreous humor or when these blood vessels lead to traction on the retina, causing retinal detachment. However, the pathogenic mechanisms important to the initiation and progression of DR are not fully understood.

In this study are presented the sonographic aspects in a group of patients with DR in your different grades.

## MATERIALS AND METHODS

It is a observational study in which are presented the sonographic aspects in a group of patients with DR in your different grades. We studied both eyes of individuals with DR by ocular sonography. The diagnostic of DR was based on the clinical and retinography examinations performed. The DR was classified according to the modified Airlie House system<sup>6,7</sup> on the basis of stereoscopic fundus examination with a 90 diopter lens. All patients agreed to sonography evaluation of the eyes, and the sonography and clinical aspects will be appears follows.

### Diabetic Retinopathy Classification

Retinopathy status was graded using the Early Treatment of Diabetic Retinopathy Scale (ETDRS). The ETDRS scale has been widely applied in research settings, publications, and meetings of retina subspecialty groups, and it has satisfactory reproducibility. The modified Airlie House classification of DR has been extended for use in the ETDRS. Airlie House Classification scheme assesses the level of retinopathy for each eye. This grading system

has been used extensively in clinical and epidemiological studies of DR, to assess baseline status of retinopathy and progression of disease<sup>8</sup>. We defined retinopathy on the basis of the ETDRS severity level in the worse eye: minimal nonproliferative retinopathy, mild nonproliferative retinopathy, moderate nonproliferative retinopathy, severe nonproliferative retinopathy, and proliferative retinopathy. The levels of the ETDRS are summarized in Table 1.

**Table 1.** ETDRS Scale of Diabetic Retinopathy Severity for individual eyes

Level	Severity
	No retinopathy
10	
20	Very mild NPDR
35	Mild NPDR
43	Moderate NPDR
47	Moderately severe NPDR
53 A-D	Severe NPDR
53 E	Very severe NPDR
61	Mild PDR
65	Moderate PDR
71 – 75	High risk PDR
81 – 85	Advanced PDR

NPDR: nonproliferative diabetic retinopathy; PDR: proliferative diabetic retinopathy

### Sonographic Examinations

Sonographic examinations were performed by an experienced sonographer using gray-scale sonographic equipment (Toshiba Aplio XG - Tokio, Japan) with a 10-MHz linear array probe. Sonograms were qualitatively analyzed by B-scan examination of the eye scanning through eyelid with small amount of gel and axial, transverse and longitudinal scans of the four major eye quadrants were obtained, and careful attention for extent of vitreous opacities and areas of high reflectivity, and topography of the alterations. The entire ocular globe was examined from the posterior pole out to the far periphery. The patients were examined in a supine position with both eyes closed. The transducer was applied gently by using a sterile coupling gel to the closed eyelids; care was taken to avoid applying any pressure to the eye. We ask the patients to look forward during the ultrasound examination to prevent eye movements.

## RESULTS

### Clinical Aspects

The individuals examined had some degree of DR, level 20 to 85 of the ETDRS. The diagnosis of DR was accomplished when at least four or more microaneurysms were present in the retinography, with or without hard or soft exudates, in the absence of other known diseases. Thus, the DR was classified in mild nonproliferative DR, moderate nonproliferative DR, severe nonproliferative DR, proliferative DR without high-risk characteristics, proliferative DR with high-risk characteristics, and patients treated previously with laser.

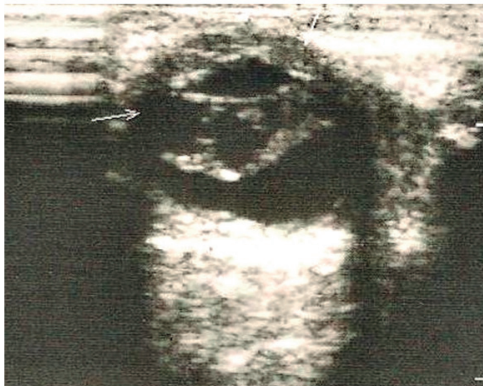
### Sonography aspects

Vitreous hemorrhage, posterior vitreous detachment, epiretinal fibrosis, and retinal detachment were main findings diagnosed by sonography examination in our study.

These ultrasound findings are described below:

#### • Vitreous hemorrhage

Vitreous is the largest structure within the eye, and the vitreous hemorrhage frequently obscures the retina from fundoscopic visualization. Sonographic aspect of vitreous hemorrhage depends of time and severity. In its early phase mild hemorrhages appear as small dots or linear areas of areas of low reflective mobile vitreous opacities (Fig. 1), whereas in more severe and older hemorrhages, blood organizes and forms membranes (Fig. 2). Inflammatory cells in vitreous are evenly distributed giving similar sonography appearance as fresh vitreous hemorrhage, while vitreous hemorrhage distributed may layer inferiorly due to gravitational forces. As the hemorrhage matures and organizes, echogenicity increases dramatically. With time, the hemorrhage will resorb, often producing an extremely heterogeneous appearance in the vitreous chamber, with numerous thick, but usually mobile, membranes (Fig. 3).

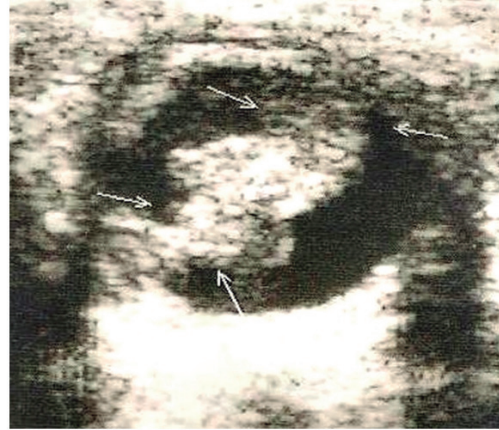


**Figure 1.** Vitreous hemorrhage - Early phase: dots and linear areas of low reflective mobile in vitreous cavity.

#### • Posterior vitreous detachment

The sonography diagnostic criteria for posterior vitreous detachment are a thin sheet of low amplitude

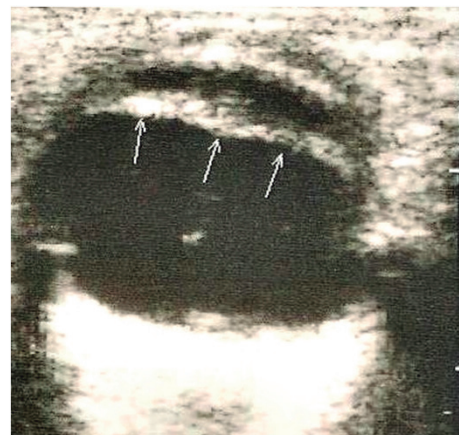
echoes or membrane seen in posterior part of vitreous cavity along the posterior hyaloid interface usually inserting into retina just anterior to equator and occasionally showing attachment to optic disc or diffuse or dispersed echoes to one or other vitreous compartment which is freely mobile on dynamic scanning and not attached to optic nerve head (Fig. 4).



**Figure 2.** Chronic vitreous hemorrhage.



**Figure 3.** Vitreous hemorrhage - Vitreous chamber with heterogeneous appearance and numerous thick membranes.



**Figure 4.** Posterior vitreous detachment - Posterior surface of detached vitreous as an echogenic line and vitreous compartment is not attached to optic nerve head.

• **Epiretinal fibrosis**

The sonographic aspect of epiretinal fibrous shows a sheet of high amplitude echoes lower in amplitude than sedimented blood showing more internal structure detected on the retinal surface, the echoes arise from epiretinal fibrous tissue. Echogenic vitreoretinal adhesions may be areas of epiretinal fibrosis and may be associated with traction retinal detachment (Fig. 5).

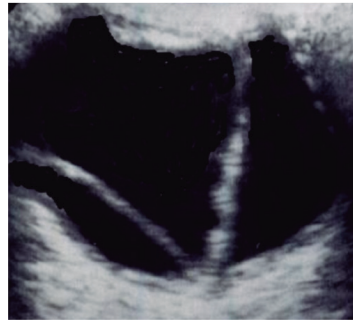
• **Retinal detachment**

The sonography is a valuable test to detect retinal detachment in diabetic eyes with opaque media due to cataract or vitreous hemorrhage. In DR the tractional retinal detachment has the following characteristics ecographic: the retinal elevation is angular in configuration and immobile on dynamic testing, there is associated epiretinal fibrosis at the summit of traction to which the posterior hyaloid membrane is attached, and the retinal surface has an anterior concavity between the limit of detachment and the vitreoretinal adhesion (Fig. 6).

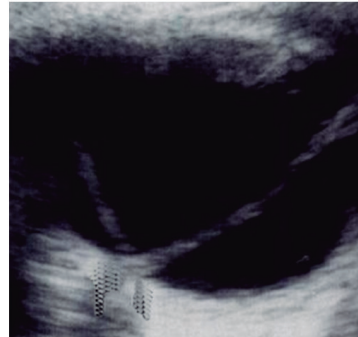
The ultrasound in the rhegmatogenous retinal detachment appears as thin continuous acoustically opaque (white) line of echoes separate from and anterior to the echoes from the wall of the choroid-scleral complex (Fig. 7). Partial retinal detachment is a relatively flat band which has a narrow acoustically empty space between detached retina and globe wall (Fig. 8). A total retinal detachment appears as highly elevated, convex echogenic line extending into the globe from its attachment points at the nasal and temporal ora serrate and posteriorly at optic disc (Fig. 9).



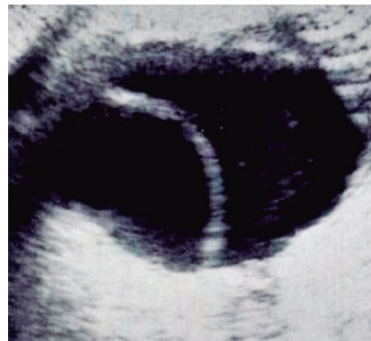
**Figure 5.** Epiretinal fibrous - Sheet of high amplitude echoes, the echoes arise from epiretinal fibrous tissue.



**Figure 6.** Retinal detachment.



**Figure 7.** Retinal detachment - Thin continuous acoustically opaque line of echoes separate from and anterior to the echoes from the wall of the choroid-scleral complex.



**Figure 8.** Partial retinal detachment.



**Figure 9.** Total retinal detachment and Vitreous hemorrhage.

**DISCUSSION**

The DR is one serious sight-threatening complication of diabetes mellitus, and the sonographic appearance of DR is illustrated in this paper.

Several methods have been used to diagnosis for DR, including ophthalmoscopy<sup>9</sup>, obtaining retinal images<sup>10</sup>, and more recently digital images with<sup>11</sup> as well as combining ophthalmoscopy with retinography<sup>12</sup>. Ocular ultrasound is a noninvasive, reproducible, and easy technique for eye exam and the ideal method for imaging of the intraocular structures in the presence of opaque ocular media.

Increase in the level of vascular endothelial growth factor is probably one of the major angiogenic factors implicated in the pathogenesis of DR. The microangiopathy and capillary occlusion together lead to microvascular leakage and breakdown of the blood retinal barrier, resulting in retinal hemorrhage and edema, as well as the development of macular edema<sup>13</sup>.

In our study the highest frequency of ultrasound abnormalities in DR was vitreous hemorrhage, epiretinal fibrosis, posterior vitreous detachment, and retinal detachment.

The vitreous does not contain any blood vessels, and the vitreous hemorrhage is the leaking of blood into one of the several potential spaces formed within and around the vitreous body of the eye owing to traction on new vessels at sites of persistent vitreoretinal adhesion, and is the commonest indication for sonographic examination in diabetic eye disease. Diabetic epiretinal vasoproliferation has like a consequence an exaggerated adhesion between the vitreous gel and the retina owing to incarceration of cortical gel in the vascularised epiretinal membrane with consequent bleeding. If extensive or repeated bleeding occurs, fibrous tissue or scarring can form on the retina, which can lead to a detachment of the retina and permanent vision loss<sup>5</sup>. Vitreous hemorrhage is associated with DR in about 60 per cent of all cases, with a traumatic insult of the eye, about 15 per cent, or with other factors, about 25 per cent, such as a hypertensive episode or subarachnoid hemorrhage<sup>14</sup>.

Ophthalmic ultrasound has become an indispensable diagnostic tool of vitreous hemorrhage, and in the present study the acute vitreous hemorrhage appears as dots and short lines on B-scan. The more dense the hemorrhage, the more opacities are seen on B-scan. Organized blood produces larger membranous surfaces on B-scan. The sonography examination of eyes with diabetic vitreous hemorrhage can be predictive for the ultimate prognosis of final visual acuity<sup>15</sup>.

Epiretinal fibrosis is a leading cause of permanent blindness in patients with advanced DR. The epiretinal fibrosis has many synonyms for this condition: epimacular proliferations, preretinal macular fibrosis, surfaces wrinkling retinopathy. The aetiology of epiretinal fibrosis may be idiopathic and found in otherwise healthy eyes, or secondary to inflammation, surgery, retinal laser and

associated with diabetes mellitus, even in the absence of other ocular complications<sup>16</sup>. Epiretinal fibrosis is symptomatic clinically only if the macular or peri-macular area is involved, presenting decreased visual acuity and metamorphopsia. B-scan sonography give additional information very important in evaluation of epiretinal fibrosis, and in our study the echographic aspects found were a sheet of high amplitude echoes lower in amplitude than sedimented blood showing more internal structure detected on the retinal surface, the echoes arise from epiretinal fibrous tissue.

The vitreous has like functions maintain the shape of the eye, shock absorber, allow transmission of light from the external environment to the retina and keep the retina in contact with the back wall of the eye<sup>17</sup>. When the vitreous separates from the retina is known as a posterior vitreous detachment, is typically an age related process that originates at the perifoveal site, gradually progresses to vitreopapillary separation, and terminates in its late stage at the vitreous base<sup>18</sup>. Diabetes induces pathology in the vitreous via non-enzymatic glycation of proteins because the vitreous in diabetics shows glycated collagen and increased amount of other proteins, leading to degenerative vitreous changes like posterior vitreous detachment that occurring in diabetics at a much younger age due formation of new retinal vessels, beyond structural changes at the vitreoretinal interface promoting migration and proliferation of vasogenic cells in the vitreous, with consequent contraction producing vitreous hemorrhage and macular edema<sup>19-22</sup>. The methods currently available for examination of the vitreous in vivo including optical coherence tomography give good information about the vitreoretinal interface but not the vitreous body therefore such changes in the vitreous may not be easily detected clinically. Thus the sonography plays a important role in the diagnosis the posterior vitreous detachment, whose sonographic features demonstrated in our study were a thin sheet of low amplitude echoes or membrane seen in posterior part of vitreous cavity along the posterior hyaloid interface usually inserting into retina just anterior to equator and occasionally showing attachment to optic disc or diffuse or dispersed echoes to one or other vitreous compartment which is freely mobile on dynamic scanning and not attached to optic nerve head.

The retina is attached at two points: the ora serrate anteriorly and the optic disk posteriorly. Retinal detachment is the end-result of neovascularization which is followed by fibrous proliferation that creates traction on the retina. Diabetic tractional retinal detachment is a severe complication of diabetic retinopathy results of combination of tangential traction, anteroposterior traction, and bridging traction. Detachment may occur at any site, but even with complete detachment, the retina always remains bound at the ora serrate and optic disk<sup>23</sup>. The sonography is very important for demonstrating of retinal detachment, and also useful for monitoring progression of retinal diseases. The ultrasonic evaluation

*helps to diagnose and to determine the timing of surgery. The sonographic features demonstrated in our study in retinal detachment were membrane-like echoes of high amplitude which tethered at the ora serrate and the optic nerve head when total. Some retinal detachments showed undulating movements on dynamic testing, but movement of the retina is usually restricted or absent. Occasionally a fibrotic posterior hyaloid membrane tethering at the optic nerve head mimic a total retinal detachment in topography and in echo amplitude.*

## CONCLUSION

*Ocular sonography is very useful diagnostic tool in detection and evaluation of DR complications, because shows the nature and extent of alterations in eyes with vitreous opacification, which is usually not visualized on ophthalmoscopy, helping to determine the clinical treatment or timing of surgery, and to predict the visual outcome. Moreover, the exam is well tolerated by the patient, no limitations and it may serve as a useful extension of the initial investigation of the symptomatic or not patient.*

*Conflict of interest: All authors declare to have no conflict of interest.*

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