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Role of Ophthalmic Brightness Scan (B-scan) Ultrasonography in Diabetic Retinopathy with Opaque Media

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ORIGINAL ARTICLE

Role of Ophthalmic Brightness Scan (B-scan) Ultrasonography in Diabetic Retinopathy with Opaque Media

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Abstract

Background: **Ophthalmic B-scan ultrasonography is a beneficial investigation in diabetic retinopathy with vitreous hemorrhage and other media opacities, where the retina cannot be visualized directly on an ophthalmic test. B-scan ultrasonography can demonstrate if the retinal detachment is present and can find other posterior segment pathology like vitreous hemorrhage and posterior vitreous detachment.**

Objective: **To investigate the role of ophthalmic brightness scan (B-scan) ultrasonography in diabetic retinopathy with opaque media.**

Patients and techniques: **A total of one hundred eyes of 100 studied cases with diabetic retinopathy at different grades with any media opacity precluding adequate indirect ophthalmoscopy were recruited between October 2020 and January 2022 at the ophthalmology outpatient clinic in Al-Azhar University Hospitals in Cairo and Kobry El-Kobba Military Eye Hospital in Cairo.**

Results: **This study showed a higher prevalence of diabetic retinopathy complications in uncontrolled diabetic patients regarding HbA1c level ≥8%, as moderate to severe vitreous hemorrhage was (98%) in uncontrolled diabetic studied cases compared to (36%) in controlled diabetic studied cases, tractional retinal detachment was (26%) in uncontrolled compared only to (2%) in controlled diabetic patients, rhegmatogenous retinal detachment was (6%) in uncontrolled compared to (0.0%) in controlled diabetic patients and combined tractional, rhegmatogenous retinal detachment was (4%) in uncontrolled compared to (0.0%) in controlled diabetic patients.**

Conclusion: **Ophthalmic B-scan ultrasonography is quick, safe, noninvasive imaging method that can be used with minimum discomfort in ophthalmological practice for detection and assessment of diabetic retinopathy problems in presence of any media opacity.**

Keywords: Diabetic retinopathy, Opaque media, Ultrasonography

1. Introduction

Diabetes mellitus is distinguished by chronic hyperglycemia and altered cellular homeostasis, which can result in multi-organ dysfunction. Diabetes-induced hyperglycemia promotes the formation and accumulation of developed glycosylation end products, which are strongly linked to a number of DM pathological problems.[1]

Diabetes affects approximately 463 million adults aged 20 to 79; by 2045, this figure is expected to increase to seven hundred million.[2]

Polyuria, polydipsia, weight loss, polyphagia, and blurred vision are symptoms of severe hyperglycemia. Chronic hyperglycemia may cause growth impairment and susceptibility to certain infections.[3]

Diabetic retinopathy is a common microvascular problem in diabetic studied cases, with type one

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diabetes mellitus having a greater incidence than type two diabetes mellitus.[4]

Clinical manifestations of vascular abnormalities in the retina are used to make diagnosis of DR. DR is categorized into 2 stages: non-proliferative diabetic retinopathy and proliferative diabetic retinopathy. NPDR is the early stage of DR in which enhanced vascular permeability and capillary occlusion are 2 major findings in the retinal vasculature.

Throughout this stage, fundus photography can identify retinal pathologies like microaneurysms, haemorrhages, and hard exudates even if studied cases are asymptomatic.

PDR, an increased stage of DR, is distinguished by neovascularization. Studied cases may experience severe vision impairment throughout this stage if new abnormal vessels bleed in the vitreous (vitreous hemorrhage) and if tractional retinal detachment is present.

Diabetic macular edoema is common reason for vision loss in DR-studied- cases. DME is characterised by macula thickening and swelling caused by sub- and intra-retinal fluid accumulation in macula caused by the breakdown of the blood-retinal barrier.[5]

Ophthalmic B-scan ultrasonography is type of imaging that can help with proliferative diabetic retinopathy. B-scan ultrasonography generates image of eye by sending great-frequency sound waves from transducer to target tissue and then returning to transducer at different time and amplitudes. These signals are then interpreted and added together to form 2D image of eye.[6]

The ocular ultra-sonogram employs piezoelectric lead-zirconate-titanate crystals, which use electricity to produce ultrasonic (inaudible, more than 20 KHz) sound waves. Ultrasonic wave travels and is reflected by any echo-dense object. Piezoelectric crystal detects reflected sound and transforms it into electric signals, which produce echogram image. If velocity of sound in medium is known, distance between object and probe can be calculated. Object's echo-density defines amount of reflected sound waves obtained by probe, and thus intensity of whiteness in B-scan and amplitude in A scan.

A scan: Amplitude of echoes is shown as vertical height from baseline as strength of echoes in amplitude scan. Horizontal distance among two echoes could be used to measure distance among two structures, similar to how axial length of eye is measured using A-scan probe throughout ocular biometry prior to cataract surgery.
B-scan: Brightness scan provides two-dimensional image of lesion's size and echotexture.[7]

In diabetic studied cases with vitreous hemorrhage (VH) and other media opacities, where retina cannot be visualized on ophthalmic test, ophthalmic B-scan ultrasonography is beneficial. B-scan ultrasonography can detect retinal detachment (RD) and other retinal pathology like vitreous hemorrhage (VH) and posterior vitreous detachment (PVD).[8]

Goal of research was to examine role of ophthalmic brightness scan (B-scan) ultrasonography in diabetic retinopathy with opaque media.

2. Patients and techniques

Total of one hundred eyes of 100 studied cases with diabetic retinopathy at changed grades with any media opacity precluding adequate indirect ophthalmoscopy were recruited between October 2020 and January 2022 at ophthalmology outpatient clinic in Al-Azhar University Hospitals in Cairo and Kobry El-Kobba Military Eye Hospital in Cairo. SONOMED (E-Z Scan AB5500+) ultrasound unit was used to define reasons for low vision in studied cases with diabetic retinopathy with opaque media. According to Helsinki Declaration principle, subjects were informed about research and asked to sign written informed consent. Study was accepted by Al-Azhar Medical study ethics committee, Faculty of Medicine, Al-Azhar University. There were no proprietary and no financial interest.

2.1. Research design

Cross-sectional descriptive comparative research.

2.2. Research place

Al-Azhar University Hospitals in Cairo & Kobry El-Kobba Military Eye Hospital in Cairo.

2.3. Inclusion criteria

Controlled diabetic studied cases with HbA1c <8% and uncontrolled diabetic studied cases with HbA1c $\geq$ eight%.

2.4. Exclusion criteria

Active corneal infection, neovascular glaucoma, previous ocular trauma and uncontrolled hypertension.

2.5. Patients

The study was conducted on 100 eyes of one hundred studied cases separated into two groups:

Group A: fifty controlled diabetic studied cases with HbA1c <8% and Group B: 50 uncontrolled diabetic studied cases with HbA1c ≥ 8%.

2.6. Methods

Studied cases were assessed containing (history, test and surveys).

2.7. History

Personal data: name, age, gender, residency, telephone number and occupation, Data related to inclusion and exclusion criteria, Past history of ocular diseases, trauma and ocular surgery and Duration of Diabetes Mellitus.

2.8. Examination

Visual acuity assessment by Landolt's C type chart: unaided and best corrected with spectacles, Anterior segment test using: slit-lamp, Fundus test using: slit-lamp biomicroscopy and indirect ophthalmoscopy.

2.9. Investigations

Ophthalmic B-scan Ultrasonography using SONOMED and Glycated Hemoglobin (HbA1c).

All sonographic tests were done by transpalpebral approach in supine or sitting position by same sonographer. Diagnostic B-mode was done using Sonomed (E-Z Scan AB5500+) ultrasonic unit, equipped with great frequency 10 MHz transducer. For more detailed inspection throughout ultrasonography, the initial test was done with great gain (80 dB–90 dB) and low gain (60 dB–70 dB) sensitivity. Appropriate duration gain compensation and dynamic range control of ultrasound echo signals were automatically set by system and manually adjusted by sonographer to achieve desired image quality on screen for efficient and accurate diagnosis of ultrasound images. Period gain compensation was used to compensate for ultrasound echo signal attenuation along depth, and dynamic range adjustment was used to control image contrast resolution. Axial, transverse and longitudinal scans were done.

2.10. Glycated hemoglobin (HbA1c)

HbA1c was got by venous blood sampling. HbA1c is product of stable linkage of glucose to N-terminal valine of beta-chain of hemoglobin. It specifies average blood glucose level over preceding 2–3 months. It reflects efficiency of diabetes treatment. As result, it is possible to evaluate body's glucose metabolism more objectively and over time than with blood glucose sample, which reflects current glucose level. Controlled diabetic patients were with HbA1c <8%. The uncontrolled diabetic patients were with HbA1c ≥ 8% (Figs. 1–5).

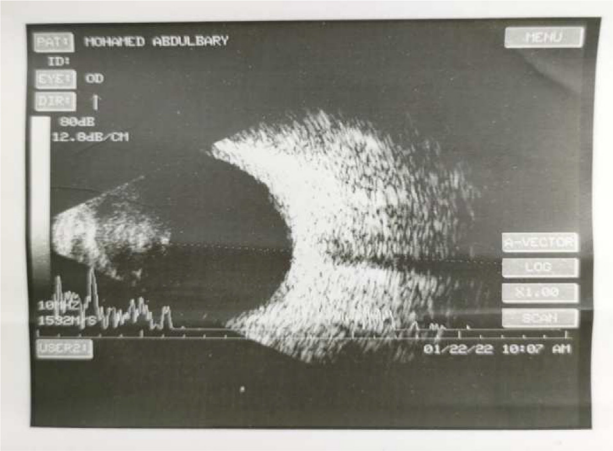

Fig. 1. Case 1 B-Scan image of right eye with corneal opacity and partially cataractous lens.

2.11. Statistical analysis

Data were collected, revised, coded, and entered into IBM SPSS version twenty three Statistical Package for Social Sciences. When parametric, quantitative data were presented as mean, standard deviations, and ranges. Qualitative variables were presented numerically and like percentages. Chi-square test was used to compare groups with qualitative data. Independent *t*-test was used to compare 2 groups with quantitative data and parametric distribution. Univariate and multivariate logistic regression analysis was done to assess most important factors associated with uncontrolled

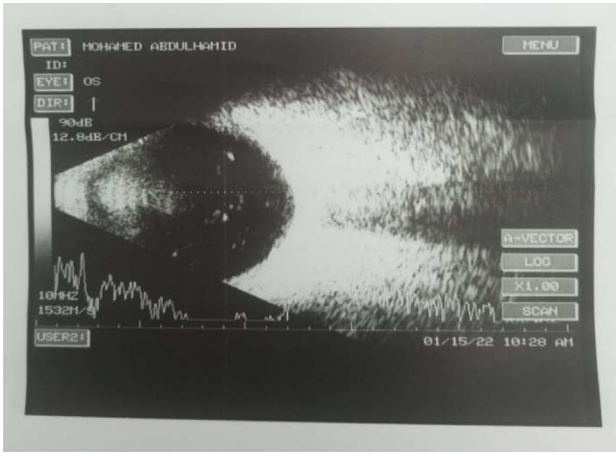

Fig. 2. Case 51 B-Scan image of left eye with totally cataractous lens and vitreous floaters.

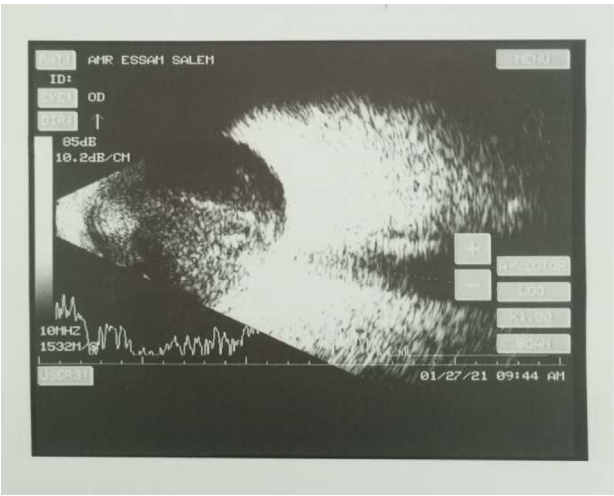

Fig. 3. Case 48 B-Scan image of right eye with partially cataractous lens and dense vitreous hemorrhage.

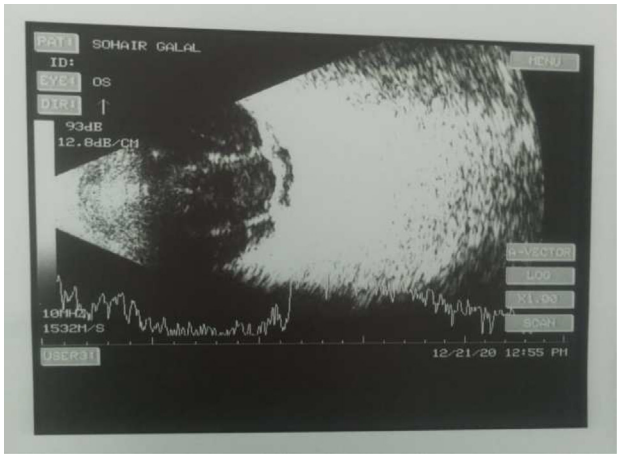

Fig. 5. Case 33 B-Scan image of left eye with Tractional retinal detachment.

HbA1c. Confidence interval was set to 95%, and acceptable margin of error was set to 5%. As result, p value was deemed significant as follows: Nonsignificant if $P > 0.05$. Significant at $< P$ 0.05. $P < 0.01$: Statistically significant.

3. Results

Table 1 founds that there was no variation among controlled and uncontrolled groups concerning age, sex and affected eye with P value 0.316, 0.160 and 0.841.

Table 2 founds that there was variation among controlled and uncontrolled HbA1c regarding duration of DM with P value = 0.009; also according to the type of diabetic treatment; the table founds that there was no variation among two studied groups concerning percentage of studied cases receiving insulin and insulin combined with oral hypoglycemic drugs with P value = 0.070 and 0.645; while there was rise in percentage of patients receiving oral hypoglycemic drugs in controlled group than uncontrolled group with P value = 0.041.

Table 3 founds that there was rise in severity of vitreous hemorrhage in uncontrolled HbA1c group than controlled HbA1c group with P value < 0.001; also percentage of studied cases with vitreous floaters was found greater in controlled group than uncontrolled group with P value = 0.001 while tractional retinal detachment percentage was found higher in uncontrolled group than controlled group with P value = 0.001 and no variation among two studied groups concerning the other findings.

The previous univariate logistic (Table 4) shows that all the previous parameters were found associated with uncontrolled HbA1c level; also the multivariate logistic regression analysis shows that the most important factor associated with uncontrolled HbA1c was found moderate to severe hemorrhage with P value < 0.001 and OR (95% CI) of 60.463 (7.519–486.232).

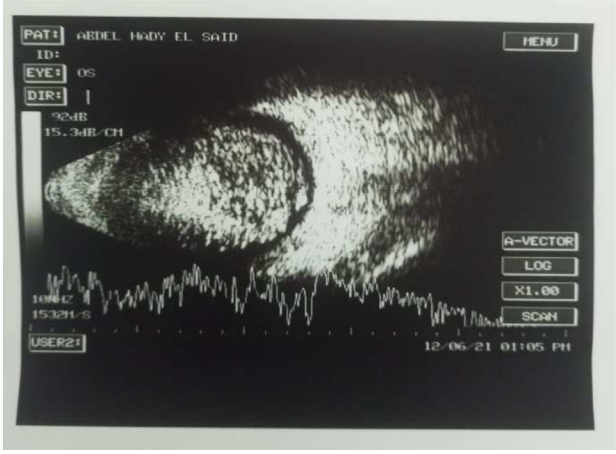

Fig. 4. Case 6 B-Scan image of left eye with asteroid hyalosis.

4. Discussion

Ophthalmic B-scan ultrasonography is valuable in diabetic studied cases with VH and any other media opacity, where retina cannot be visualized directly on ophthalmic test.

This study investigated the role of B-Scan U/S in diabetic retinopathy with opaque media in Egypt according to their HbA1c (%) as presented. Studied case's years old varies from 33 to 89.

Our research found that eyes of diabetic studied cases are vulnerable to numerous pathologies in studied cases with uncontrolled HbA1c $\geq$ 8% in comparison to controlled HbA1c <8%.

Table 1. Comparison of controlled HbA1c and uncontrolled HbA1c regarding demographic data.

	Controlled HbA1c Number50	Uncontrolled HbA1c Number50	Test value	*P* value	Sig.
Years old					
Mean ± SD	61.16 ± 10.37	63.06 ± 8.38	−1.007[b]	0.316	NS
Range	33–89	42–88			
Sex					
Female	9 (18.0%)	15 (30.0%)	1.974[a]	0.160	NS
Male	41 (82.0%)	35 (70.0%)			
Eye					
Right	22 (44.0%)	23 (46.0%)	0.040[a]	0.841	NS
Left	28 (56.0%)	27 (54.0%)			

[*P* value > 0.05: Not significant; *P* value < 0.05: Significant; *P* value < 0.01: greatly significant].
[a] Chi-square test.
[b] Independent *t*-test.

B-Scan Ultrasonography was used in our study with a transpalpebral examination protocol with studied case in supine or sitting site. As regard demographic data of cases, Age of studied cases ranges from (33–89) years (with mean age SD 62.11 ± 9.43), Sex distribution was 24 (24%) female patients and 76 (76%) male patients, 45 of the studied eyes were right, the remaining 55 eyes were left. Duration of DM ranges from (2–40) years with (mean duration±SD = 18.46 ± 7.48 years), 55 patients were on insulin, 40 patients were on oral hypoglycemic drugs and only 5 patients were on both treatment modalities.

Our study reported that patients with diabetic duration <22 years were the most affected patients.

The results of our study showed higher prevalence of diabetic retinopathy complications as moderate to severe Vitreous heamorrhage was (98%) in uncontrolled diabetic studied cases compared to (36%) in controlled diabetic studied cases, Also, retinal detachment was (36%) in uncontrolled diabetic studied cases compared only to (2%) in controlled diabetic studied cases, partial retinal detachment was (72.22%) while total retinal detachment was (27.78%), tractional retinal detachment was (26%) in uncontrolled compared only to (2%) in controlled diabetic patients regarding HbA1c level, rhegmatogenous retinal detachment was (6%) in uncontrolled compared to (0.0%) in controlled diabetic patients and Combined tractional, rhegmatogenous retinal detachment was (4%) in uncontrolled compared to (0.0%) in controlled diabetic patients.

Other sonographic findings were partially cataractous lens by (44%) and (40%), totally cataractous lens by (56%) and (58%), moderate to sever subhyaloid hemorrhage by (14%) and (12%), partial posterior vitreous detachment by (18%) and (22%), total posterior vitreous detachment by (24%) and (12%), asteroid hyalosis by (8%) and (2%) and corneal opacity by (0.0%) and (2%) in uncontrolled and controlled diabetic patients respectively.

However, mild vitreous hemorrhage was higher in controlled (32%) than in uncontrolled (2%) group, mild subhyaloid hemorrhage was (8%) in controlled compared to (0%) in uncontrolled group and vitreous floaters were (20%) in controlled compared to (0%) in uncontrolled group.

In comparison with preceding research, performed by Mohamed et al.[3] in which group of one hundred studied cases with DR at altered grades, completed standard ophthalmology tests and ophthalmic B-scan ultrasonography test.

In agreement with our results total of 75 (75%) studied cases were men and rest 25 (25%) were

Table 2. Comparison of controlled HbA1c and uncontrolled HbA1c regarding duration of DM and type of diabetic treatment.

	Controlled HbA1c Number50	Uncontrolled HbA1c Number50	Test value	*P* value	Sig.
Duration of DM (years)					
Mean ± SD	16.52 ± 6.93	20.40 ± 7.57	−2.673[b]	0.009	HS
Range	2–30	5–40			
Type of Diabetic Treatment					
Insulin	23 (46.0%)	32 (64.0%)	3.273[a]	0.070	NS
Oral hypoglycemic drugs	25 (50.0%)	15 (30.0%)	4.167[a]	0.041	S
Both	2 (4.0%)	3 (6.0%)	0.211[a]	0.645	NS

[*P* value > 0.05: Nonsignificant; *P* value < 0.05: Significant; *P* value < 0.01: greatly significant].
[a] Chi-square test.
[b] Independent *t*-test.

Table 3. Comparison of controlled HbA1c and uncontrolled HbA1c regarding sonographic findings of the studied patients.

	Controlled HbA1c Number (%)	Uncontrolled HbA1c Number (%)	Test value[a]	*P* value	Sig.
Corneal opacity					
No	49 (98%)	50 (100%)	1.010	0.315	NS
Yes	1 (2%)	0 (0%)			
Cataract					
No	1 (2.0%)	0 (0.0%)	1.113	0.573	NS
Partial	20 (40.0%)	22 (44.0%)			
Total	29 (58.0%)	28 (56.0%)			
Vitreous hemorrhage					
No	16 (32.0%)	0 (0.0%)	43.579	0.000	HS
Mild	16 (32.0%)	1 (2.0%)			
Moderate to severe	18 (36.0%)	49 (98.0%)			
Asteroid hyalosis					
No	49 (98.0%)	46 (92.0%)	1.895	0.169	NS
Yes	1 (2.0%)	4 (8.0%)			
Vitreous floaters					
No	40 (80.0%)	50 (100.0%)	11.111	0.001	HS
Yes	10 (20.0%)	0 (0.0%)			
Subhyaloid hemorrhage					
No	40 (80.0%)	43 (86.0%)	4.185	0.123	NS
Mild	4 (8.0%)	0 (0.0%)			
Moderate to severe	6 (12.0%)	7 (14.0%)			
Tractional retinal detachment					
No	49 (98.0%)	37 (74.0%)	11.960	0.001	HS
Yes	1 (2.0%)	13 (26.0%)			
Rhegmatogenous					
No	50 (100.0%)	47 (94.0%)	3.093	0.079	NS
Yes	0 (0.0%)	3 (6.0%)			
Combined tractional and rhegmatogenous					
No	50 (100.0%)	48 (96.0%)	2.041	0.153	NS
Yes	0 (0.0%)	2 (4.0%)			
Posterior vitreous detachment					
No	33 (66.0%)	29 (58.0%)	2.458	0.293	NS
Incomplete	11 (22.0%)	9 (18.0%)			
Complete	6 (12.0%)	12 (24.0%)			

[*P* value > 0.05: Nonsignificant; *P* value < 0.05: Significant; *P* value < 0.01: greatly significant].
[a] Chi-square test.

women. Mean time of diabetes in sample was (18.9 ± 1.7 years) with disease time ranges from 11 to 29.

In contrast to our study mean age±SD was 46.4 ± 1.4 years with years old varies from fourteen up to seventy nine. In comparison with our results Mohamed et al.[3] showed that, the ultrasound findings of vitreous hemorrhage (40.5%), total retinal detachment (32.4%) and posterior vitreous detachment (19%), were dominant in studied cases classified with regulated HbA1c (11.9 ± 1.1).

While, the ultrasonographic findings in moderately regulated HbA1c (9.55 ± 1.7) were vitreous hemorrhage (66.6%), partial retinal detachment (19%) and AH (14.3%), they were the main causes of low vision in that group.[3]

Table 4. Logistic regression analysis for predictors of uncontrolled HbA1c.

	Uni-variety				Multi-variety			
	P value	Odds ratio	95% C.I. for OR		*P* value	Odds ratio	95% C.I. for OR	
			Lower	Upper			Lower	Upper
Duration of DM > 22	0.008	3.765	1.410	10.051	0.136	2.872	0.718	11.481
Oral hypoglycemic drugs	0.043	0.429	0.189	0.974	0.795	0.854	0.260	2.808
Moderate to sever hemorrhage	0.000	87.111	11.077	685.084	0.000	60.463	7.519	486.232
Tractional retinal detachment	0.007	17.216	2.155	137.567	0.091	6.470	0.744	56.232

There was a variation among controlled HbA1c and uncontrolled HbA1c concerning the duration of DM with P value = 0.009; the longer the duration of DM, the more the likelihood of uncontrolled HbA1c and so, the higher occurrence of diabetic retinopathy and its complications.

In agreement with our results, the occurrence of diabetic retinopathy was (24.8 %) in studied cases with diabetes for < five years, whilst (90.3%) cases had diabetes mellitus for twenty years and more. As time of diabetes enhanced, so did the prevalence of retinopathy.[9]

Also, according to the type of diabetic treatment; there was a rise in the percentage of studied cases receiving oral hypoglycemic drugs in a controlled group than the uncontrolled group with P value = 0.041. In agreement with our results, the prevention of long-term problems of type two diabetes is aided by optimal glycemic control, particularly in the early years after diagnosis.[10]

5. Conclusion

Ophthalmic B-scan ultrasonography is quick, safe, noninvasive imaging method that can be used with minimum discomfort in ophthalmological practice for finding and assessment of diabetic retinopathy problems, as it founds nature and extent of diabetic impacts in eyes with any media opacity, which is not visualized clinically on ophthalmoscopy, helping define clinical therapy, timing of surgery, and forecast visual result. HbA1c is a very important modifiable risk factor for both postponing and prevention of DM complications especially diabetic retinopathy. Longer time of diabetes mellitus, greater incidence of diabetic retinopathy complications.

Authorship

All authors have a substantial contribution to the article.

Disclosure

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Conflict of Interest

The authors declared that there were no conflicts of Interest.

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