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Pattern of Ocular B-Mode Sonographic Findings in Diabetic Ophthalmopathy in Zaria, Nigeria

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ABSTRACT

***Objectives**: This study was aimed at using B-Mode ultrasonography to evaluate the various changes in the eyes of diabetic patients.*

***Methods:** The study was conducted with DC 6 Mindray ultrasound machine within a period of six months at the Radiology Department of ABUTH, Zaria. 200 established diabetic patients with ocular complications aged 15 to 70 years were recruited for the study as case group and 200 established diabetic patients without ocular complication as control group.*

***Results**: A total of 800 eyes of 400 patients were involved in this study; 200 diabetic patients with ocular complications as case group and equal number of diabetic patients without ocular complications as a control group. The age range of the patients was 15-70 years (54.16 ± 12.0). 164 were males and 236 were females. Out of the 200 cases studied, vitreous haemorrhage was the commonest finding 195(97.5%), followed by cataract 54(27%), Posterior vitreous detachment 28(14%), Retinal detachment 7(3.5%), optic nerve drusen 6(3%), Vitreous liquefaction 5(2.5%), Epiretinal fibrosis 3(1.5%), Asteroid hyalosis 3(1.5%), and intraocular infection 1(0.5%). In the control group however, 27 (13.5%) had vitreous haemorrhage while the remaining 173 (86.5%) showed normal sonographic findings. Sonographic Findings in the case group were significantly higher than those in the control ($p<0.05$).*

***Conclusion**: The utility of ultrasonography in the detection of ocular complications in diabetic patients is re-echoed in this study, and diabetic patients should benefit from this safe radiological evaluation as that will aid early detection of the aforementioned complications.*

Keywords

Diabetes Mellitus, Ocular complications, B-mode ultrasonography.

Introduction

Diabetes mellitus (DM) is a common metabolic disorder that shares the phenotype of hyperglycaemia [1]. Several distinct types of DM exist, with Type 1 and Type 2 DM commonly identified and are caused by a complex interaction of genetics, environmental factors and life style choices [1]. Depending on the aetiology of DM, factors contributing to hyperglycaemia include reduced insulin secretion, decreased glucose utilization and increased glucose production [1]. DM is the most common endocrine disorders affecting almost 6% of the world population [2]. Currently more than 371 million people have DM in the world and over 14 million of these are in the Africa sub-region with Nigeria accounting for the highest cases [3]. The Nigeria National prevalence reported in

1997 was 2.2%, and with a current 2.4% prevalence estimates, it then means that 3.2 million Nigerians have diabetes mellitus [3]. More than 90% of the cases in Nigeria are Type 2, which is also the predominant type worldwide [3].

Due to the indolent course of diabetes mellitus, patients tend to present with systemic complications with the eye being one of the target organs affected. The World Health Organization (W.H.O) data on visual impairment in 2010 featured diabetes mellitus prominently among the causes of low vision, visual impairment and blindness globally [4]. Diabetic retinopathy is a well-known single most important ocular complication of DM and the leading cause of blindness among people 20-64 years of age in United State [5]. However, in developing countries like Nigeria, even though diabetes mellitus and its associated ocular complications are not the leading causes of blindness, they are prevalent and are therefore an important public health problem [6]. In developing countries, Nigeria inclusive, common causes of bilateral vision loss include cataract, glaucoma, vitamin A deficiency, trachoma and onchocerciasis [6]. It is important to note that cataract and neovascular glaucoma, which are commonly seen in Nigeria, are also associated with diabetes mellitus.

Studies at different centres in Nigeria observed that diabetic eye diseases specifically diabetic retinopathy are prevalent and not uncommon encounter in endocrine, metabolic and ophthalmologic clinics [6-9].

Imaging of the eye is critical to improving diagnosis, assessment of severity, and progression of the disease [5]. Ophthalmologists employ various techniques of Eye examination such as slit lamp and fundus photography, scheimpflug laser polarimetry, laser opthalmoscopy, scanning laser polarimetry, retinal photography, confocal scanning microscopy, and optical coherence tomography [10]. However, ocular-B-mode ultrasonography has proven to be an invaluable adjunct in assessing the eyes in diabetics and other ocular pathologies especially when difficulties are encountered in visualizing the posterior segment, particularly in patients with dense cataract. In view of this, some ophthalmologists are advocating the routine pre-surgical ocular B-mode ultrasonographic screening of all patients with cataract to exclude co-existing posterior segment lesions. A study conducted by Manzar and Khalida in a University Eye Hospital in Pakistan to determine the role of B-mode scan in preoperative cataract patients revealed that, out of the 750 patients evaluated, 90 (12%) patients had coexisting posterior segment lesions which could be missed without ultrasonography [11]. They concluded their study with a strong recommendation for routine use of B-mode ocular scan for pre-operative evaluation of cataract patients. The use of B mode ultrasound in the evaluation of eye diseases is not new in Nigeria; a study conducted in Benin; Nigeria revealed 92.3% correlation between clinical diagnosis and B-scan ultrasound diagnosis and hence recommended its use [12].

Despite the eye complications in patients with DM, few studies in our environment are targeted at using B-Mode ultrasonography to assess the eyes of such patients hence, the motivation for this study. It will further help to establish the possible findings in the eyes of diabetic patients with ocular complications and by extension, guide early treatment and then avert the devastating sequalae of such findings.

Materials and Methods

This prospective case control study was carried out within 6 months in the Department of Radiology, Ahmadu Bello University Teaching Hospital (ABUTH), Zaria after an approval was granted by the Ethical and Research committee of the institution. Consecutive four hundred (400) clinically established diabetic patients aged 15 to 70 years were recruited for the study; two hundred (200) eligible diabetics with ocular complications as cases and two hundred (200) diabetic patients without ocular complications as controls.

Those excluded from the study were Patients with current eye diseases that are not related to diabetes mellitus, diabetic patients with sickle cell disease, thyroid ophthalmopathy, ocular trauma, or recent eye surgery.

In this study, ocular complications were considered as those diabetic patients whose visual acuity was less than 6/18. The control group were diabetic patients with no ocular complications whose visual acuity was greater. Having obtained informed consent, the procedure was explained to all eligible participants and questionnaires were administered. Their eyes were examined on B-Mode Gray scale ultrasonography with Mindray DC-8 ultrasound machine using high frequency (7.5MHz -10MHz) linear array transducer after application of coupling gel, and the findings were documented appropriately in the data form. The ocular scan was done with the patients lying supine, gazing vertically upward and eyelids gently closed. Imaging of the eye was performed one at a time in two planes to ensure complete evaluation of the orbit [13].

Once the entire globe was evaluated, findings were recorded in a data sheet. Patients were reassured and tissue wipe was used to gently clean the ultrasound gel applied to the lids.

Ethical Considerations

Approval for the study was obtained from the ethics and research committee of Ahmadu Bello University Teaching Hospital **(ABUTH/HREC/TRG/36).** Anonymity was maintained on the information obtained and the patients had choice to deny consent or opt out of the study at any stage with no direct effect on the quality of care obtained in the hospital.

Data Analysis

The results were reported as mean ± (SD). The collected data were analysed using Statistical Package for Social Science (IBM SPSS) version 20 software INDUS Nomi2011 IBM Chicago, USA. All test of significance were two-tailed, and P-values ≤ 0.05 were considered statistically significant.

Results

A total of 800 eyes of 400 patients were involved in this study, comprising 200 diabetic patients with ocular complications (400 eyes) as case group and equal number of diabetic patients without ocular complications as a control group. The age range of the patients was 15-70 years with a mean age of 54.16 ± 12.0 years. As indicated in table 1, the highest number of patients (68), representing 34% were in the 61-70 age group while the least number (4) representing 4% was noted in ≤ 20 age group. 164 of the patients (41%) were males while females were 236, constituting 59%, with a male to female ratio of 1:1.4.

Table 1: Cross tabulation showing age and sex distribution in the control and case groups.

Age Group	Control				Case	
	Male	%	Female	%	Male	Female
≤ 20	2	1	2	1	2	2
21 - 30	4	2	4	2	4	4
31 - 40	4	2	8	4	4	8
41 - 50	19	9.5	28	14	19	28
51 - 60	24	12	37	18.5	24	37
61 - 70	29	14.5	39	19.5	29	39
Total	82	41	118	59	82	118

Most of the cases were Type 2 DM in the study. Type 1 DM was identified in 8 and 6 patients in both case and control representing 4% and 3% respectively. Whereas 192 (96%) and 194 (97%) for case and control group respectively had Type 2 DM. In this study also, varied findings were noted in both case and control groups with some patients having multiple findings. This is depicted in tables 2a and 2b. Out of the 200 patients studied in case group, vitreous haemorrhage (VH) was the highest finding noted in 195 (97.5%), followed by cataract (CTR) 54 (27%), Posterior vitreous detachment (PVD) 28 (14%), Retinal detachment 7 (3.5%), (optic nerve drusen) 6 (3%), Vitreous liquefaction 5 (2.5%), Epiretinal fibrosis (EF) 3 (1.5%), Asteroid hyalosis (AH) 3 (1.5%), with the least finding of intraocular infection (II) in 1 patient, constituting 0.5% (Figures 1 & 2). In the control group however, 27 (13.5%) had vitreous haemorrhage (VH) while 173 (86.5%) had normal sonographic findings. Multiple pathologic findings were noted among the case group compared to the control group and this observation was statistically significant (p-value = 0.0288).

Table 2a: Summary of ultrasonographic findings among case and control groups.

FINDINGS			Case	Control	Total
Vitreous Haemorrhage (97.5%)			**195**	**27**	**222**
{VE-H}		Left	3	1	
		Right	2	1	
		Both	190	25	
Cataract (27%)			**54**	**0**	**54**
{CTR}		Left	4	-	
		Right	7	-	
		Both	43	-	
Posterior Vitreous Detachment (14%)			**28**	**0**	**28**
{PVD}		Left	10	-	
		Right	5	-	
		Both	13	-	
Retinal Detachment (3.5%)	Total Detachment		**3**	**0**	**3**
{RD}		Left	2	-	
		Right	1	-	
	Subtotal Detachment		**4**	**0**	**4**
		Left	3	-	
		Right	1	-	
Optic nerve head drusen (3%)			**6**	**0**	**6**
		Left	4	-	
		Both	2	-	
Vitreous Liquefaction (2.5%)			**5**	**0**	**5**
{VE-L}		Both	5	-	
Asteroid Hyalosis (1.5%)			**3**	**0**	**3**
{VE-AH}		Left	3	-	
Epiretinal Fibrosis (1.5%)			**3**	**0**	**3**
{EF}		Left	2	-	
		Right	1	-	
Intraocular Inflammation (0.5%) {VE-II}		Right	**1**	**0**	**1**
Normal (86.5%)			**0**	**173**	**173**
		Left	-	1	
		Right	-	1	
		Both	-	171	

Table 2b: Shows pathologic ultrasonographic findings among the case and control groups.

Findings	Case	control	Total
VE-H	195	27	**222**
EF	3	0	**3**
RD	7	0	**7**
PVD	28	0	**28**
CTR	54	0	**54**
OTHERS	6	0	**6**
Total	**293**	**27**	**320**
p = 0.028			

Figure 1: Bar Chart showing ultrasonographic findings in the case and control groups.

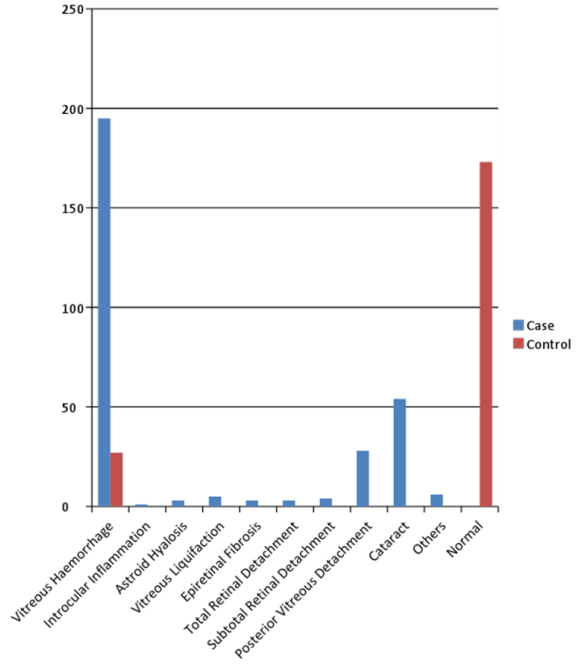
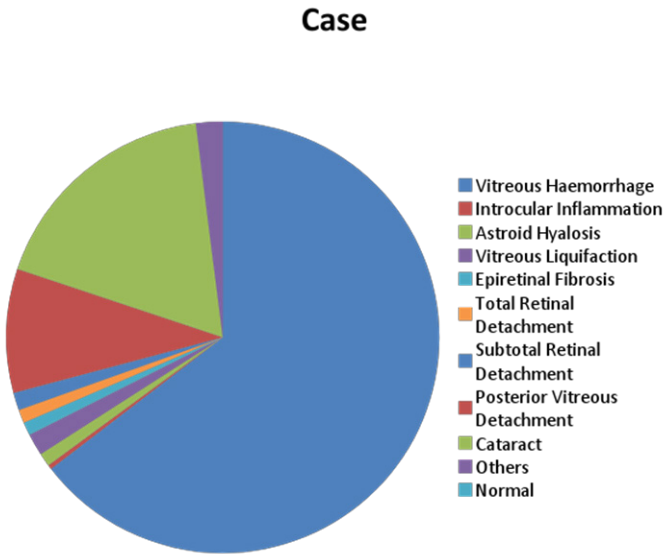


Figure 2: Pie Chart showing ultrasonographic findings in the case group.



The distribution of the ultrasonographic findings in both groups and its correlation with age (Tables 3a and 3b) shows highest multiplicity of findings in the age group 61-70, followed by 51-60 age group and those within the age group ≤ 20 had sole finding of vitreous haemorrhage. The only finding noted in the control group was vitreous haemorrhage and this was observed in the 61- 70 age group. No gender discrepancies were observed in the frequency of findings. The Vitreous haemorrhage (Figure 3) was the commonest finding in both males and females while the least finding was epiretinal fibrosis (Figure 4).

Table 3a: Distribution of Ocular B- scan findings among different age groups in the case group.

Age group	VE (H)	VE (II)	VE (AH)	VEL	EF	RD	PVD	CTR	OTHERS
≤20	4								
21-30	8						1		
31-40	12							1	1
41-50	48	1	1				5	8	2
51-60	58		2			2		19	2
61-70	65		3	3	3	5	11	26	1

Table 3b: Distribution of Ocular B- scan findings among different age groups in the control group.

AGE GROUP	VE (H)
≤20	1
21-30	1
31-40	1
41-50	6
51-60	6
61-70	12
Total	**27**

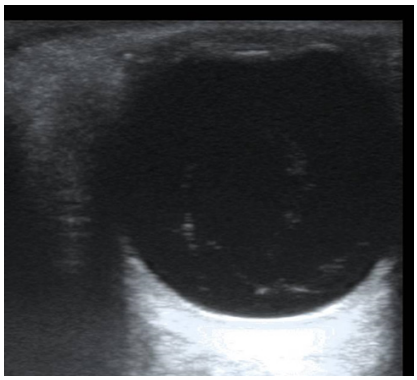


Figure 3: Showing vitreous haemorrhage with echogenic strands and membranes in a 56-year-old female diabetic patient.

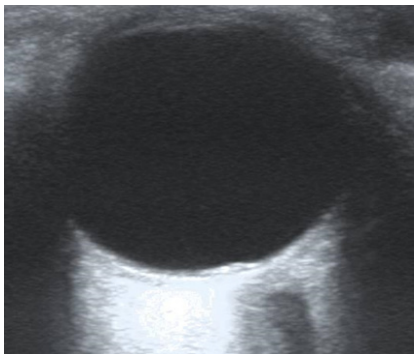


Figure 4: Transverse ocular B Scan in a 61-year-old male showing echogenic focus on the retina (Epiretinal fibrosis).

Tables 4a & b show the distributions of findings based on the type of diabetes mellitus; 8 of type 1 DM patients had vitreous haemorrhage (VE -H) while 1 patient had posterior vitreous detachment-PVD (Figure 5). Among those with type 2 DM patients, different findings ranging from VE-H, CTR, EF, PVD to retinal detachment (RD) were observed. RD (Figure 6) was particularly found among those that were advanced in age. In the control group, only 2 patients with Type 1 DM had vitreous haemorrhage. While the remaining patients (25) with vitreous haemorrhage were observed in those with type 2 DM.

Table 4a: Distribution of findings based on the type of diabetes mellitus in case group.

TYPES OF DIABETICS	FINDINGS
TYPE 1	VE-H (8)
	PVD (1)
TYPE 2	VE-H (187)
	VE-AH (3)
	VE- II (1)
	VE-L (5)
	EF- (3)
	RD- (7)
	PVD- (27)
	CTR- (54)
	OTHERS- (6)

Table 4b: Distribution of findings based on the type of diabetes mellitus in control group.

Types of DM	Findings
Type 1	VE-H (2)
Type 2	VE-H (25)

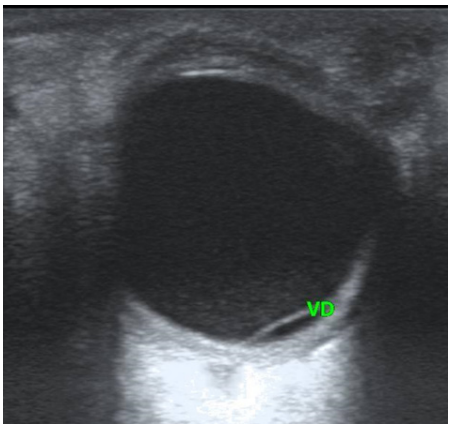


Figure 5: Longitudinal ocular B- scan in a 54-year-old female diabetic patient showing posterior vitreous detachment.

Figure 6: Longitudinal ocular B scan in a 64-year-old diabetic patient showing total retinal detachment.

Discussion

Ocular complications in diabetics are documented facts in the literature and most of the patients affected globally are those with type 2 DM that occurs commonly in the aged population. Our observation in this study concurred with this as most of our patients (88%) with ocular complications were above 40 years and those between 60- and 70-year age group predominated. This is similar but slightly higher than the observation of David et al. [14] where 77.5% of their study population were aged above 40years.

Females constituted majority of the patients representing 59% of our research participants. This is most likely due to the fact that one of the commonest ocular complications in diabetic patients which is DR is commoner in females [15]. Another explanation could be the fact that women have better health seeking behaviour than men as reported by some authors [16,17]. However, David and Restori observed male preponderance of 60% in their study, which is a rare occurrence [13].

In the index study, type 1 and type 2 diabetes were the only two types of DM identified representing 8 (4%) and 192 (96%) respectively in the case group and 6 (3%) and 194 (97%) respectively in the control group. This also concurs with the observation of other authors where type 1 and type 2 are the commonly diagnosed types of DM worldwide accounting for 5-10% and 90-95% respectively [18].

It was also observed in this study that the patients had varied duration of DM with minimum duration of 2 years and maximum duration of 25 years in the case group and majority of the participants' symptoms were within 5years with least number falling within 21-25 years. The control group had lesser duration of DM symptoms compared to the case group, which was statistically significant ($p < 0.001$). Studies based on ophthalmoscopic examination implicated duration of DM as one of the most important factors responsible for diabetic retinopathy and other orbital complications [15,19].

Compliance to treatment is not as important as the duration of DM in terms of developing DM complications specifically diabetic retinopathy (DR) [15] but complications like intraocular inflammation/infection is commoner in those with poor control most probably due to the fact that high glucose concentration in the blood is a good medium for bacteria and other pathogens. In this study, majority of the patients in the case group (76.5%) complied with medications while 78% of those in control group volunteered information of full compliance with their medications, which therefore negates poor compliance to medication as a reason for the observed sonographic ocular complications.

Hypertension is often found in patients with DM and it is considered as one of the important co-morbidities in patients with DM who developed DR. [15,19,20]. Most researchers believed that severity and acceleration of the disease process in DR is related to hypertension [21]. It was observed in the index study that the control group had less patients with co-existing hypertension as compared to patients in case group which was statistically significant, p-value < 0.001. In addition, in a study based on slit lamp and fundoscopic examination in Enugu Nigeria, out of the 19 patients found to have DR, 9 (47%) had hypertension, which explained why a good number of patients in our case group had DR as against control group [22].

In this study also, varied findings were noted in the case group with some patients having multiple findings. Vitreous haemorrhage was the highest and most noticeable finding in 385 eyes of case group, representing 97.5% of the patients. The observed high detection rate of vitreous haemorrhage can be attributed to the sensitivity and specificity of ocular B Scan in this scenario. In a study conducted to determine the validity of ultrasound B scan compared to slit lamp in the diagnosis of posterior segment

pathologies among diabetic eyes in Tikrit and Baghdad Iraq [23], the sensitivity, specificity, positive predictive value, and negative predictive value of ultrasound to diagnose vitreous haemorrhage was 87%, 99%, 82% and 99% respectively which is in tandem with our observation in this study. In a previous study conducted by David et al. [14] vitreous haemorrhage was identified in 134 eyes out of the 154 eyes examined by ultrasound, representing 76.1%, which is still relatively high and further confirms the sensitivity and specificity of ocular B mode ultrasound scan. In our study also, majority of the vitreous haemorrhages were observed in both eyes in 97.4% of cases, while unilateral involvement was noted in 5 patients, constituting 2.6% of the patients. Since DM is a systemic disease, bilateral affectation is not unusual even though local hemodynamic of the paired organs may affect the severity and involvement of one against the other. It was also observed that the severity and appearances of the haemorrhage varied, ranging from echogenic foci settling posteriorly to membranous strands and even organized hematoma given a pseudo tumour appearance. These findings are similar to the observation of other authors [14,24]. Even though this study focused on identifying findings, some researchers extended their work in this area to include predicting the prognosis of diabetes vitreous haemorrhage, with findings like low density of the blood in the vitreous cavity, posterior vitreous detachment without vitreo-retinal traction and blood in the subvitreal space as the main findings associated with vitreous haemorrhage that will clear with time. On the other hand, findings like high or moderate density of the blood and vitreous detachment with vitro-retinal traction site are findings linked with non-clearing diabetic vitreous haemorrhage that will eventually require surgical intervention (vitrectomy) [25]. Interestingly, 27 of the control group representing 13.5% had vitreous haemorrhage but the severity and appearances differ with the case group. It was observed to be of mild to moderate severity as against those in the case group. This observation may be due to shorter duration of symptoms of the patients in this category.

Features of intraocular infection was noted in only 1 (0.5%) patient which was unilateral in the left, even though intraocular infection is common in diabetic patient with poor control [26], the short duration of our study might have contributed to the single case recorded. Only 3 patients representing 1.5% had unilateral asteroid hyalosis in the index study and it is also linked to DM by some authors [15]. 5 patients (2.5%) were noted to have features of vitreous liquefaction (floaters) which is a condition commoner with DM patients than general population. Three patients representing 1.5% in the study had fibrotic focus on the retinal surface (epiretinal fibrosis) with two in the left and one on the right, 7 (3.5%) patients had retinal detachments, with 3 and 4 having total and partial detachments respectively. 28 (14%) had posterior vitreous detachments; 13 (46%) were bilateral while 15 (54%) had unilateral affectation with ten affecting the left and five on the right. However, these findings are much lower than what was reported by previous authors [14] where epiretinal fibrosis, retinal detachments and posterior vitreous detachment accounted for 42%, 57%, 94% respectively. The high rate observed in these studies compared to our study may be due to the simple inclusion criteria of visual impairment and/or eye pain/swelling.

54 patients representing 27% had cataract, with bilateral distribution in 43 (86%) and unilateral involvement in the remaining 11 (14%) with left having 4 and right having 7. Diabetic patients are six times more prone to cataract compared to individuals without the disease and the preponderance of bilateral involvement in our study is largely due to the systemic nature of the disease [27]. In the study of other authors using fundoscopy, slit lamp and torchlight examination conducted in Enugu Nigeria among 149 diabetic eye disease patients, 33 (22.1%) had cataract [28]. This is similar to our observation in the index study.

However, other finding that was observed in 6 (3%) patients was optic nerve head drusen with 4 unilateral involvements in the left, and 2 bilateral. This finding is associated with variety of ophthalmic condition including DM.

Multiplicity of pathologic findings were highest among 61-70 age group in the index study, followed by 51-60 age group with least findings among those less than 20 years old. Similar pattern was noted among the control group. This may be attributed to the expected prolonged duration of symptoms among the elderly as compared to the younger patients.

In addition, the distribution of ultrasonographic findings based on gender distribution revealed that the highest finding among male and female group was vitreous haemorrhage representing 79 (40.5%) and 116 (59.5%) in the male and female respectively. The least finding was epiretinal fibrosis in male and intra ocular inflammation in female. Similar pattern was observed in the control group where ocular findings and complications were commoner in females. This is also a reflection of the study population where females constituted the majority of the patients most likely due to their good health seeking behaviour as against their male counterparts. In addition, gestational diabetics may also be considered as one of the reasons accounting for higher prevalence of diabetics and diabetic complications in females [29].

The distribution based on type of DM revealed that majority of the findings among type 1 patients was vitreous haemorrhage and the least finding was PVD, and the remaining findings were noted in patients with type 2 DM. However, Studies have shown that both types of DM are associated with ocular complications [30]. However, since there are disproportionate number of patients among the two types of DM in favour of Type 2, we may not experience varied findings in Type 1 as it was with Type 2 DM patients. Most Type 1 patients are younger patients with lower duration of the disease; the longest duration recorded in type 1 was 7 years as against Type 2 DM patients where 25 years was the longest duration recorded. Duration of the disease should therefore be strongly considered as the reason for the ocular complications and not just the type of DM since the pathophysiology of the two types is similar.

Out of the 400 patients in both control and case group, none of the patients had ever done ocular B mode scan since when diagnosed of DM or since the onset of eye symptoms. This has further brought to the fore the poor utilization of this cheap and safe imaging modality among clinicians practising in a resource poor nation like Nigeria.

Conclusion

The study had succeeded in demonstrating the utility of Ocular B-Mode sonography in the detection and evaluation of diabetic patients with or without ocular complications. It is not aimed at replacing the conventional ophthalmoscopic examinations but rather an adjunct to them. In view of its numerous advantages such as affordability, accessibility, convenience, reproducibility, reliability and non-use of ionizing radiation in image acquisition, it is therefore recommended that ocular ultrasound should be included as a baseline investigation in the evaluation of all diabetic patients with or without ocular complications.

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