PLATELET INDICES: INDICATORS OF DIABETIC RETINOPATHY

by Jana Publication & Research

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PLATELET INDICES: INDICATORS OF DIABETIC RETINOPATHY

ABSTRACT

• AIM AND OBJECTIVES: The aim of this study is to study role of platelet indices in type 2 diabetes mellitus (T2DM) with and without diabetic retinopathy. The objectives included assessing platelet count, mean platelet volume (MPV), platelet distribution width (PDW), and platelet large cell ratio (P-LCR) within these patient categories and to comparing platelet indices among healthy controls, diabetic patients without retinopathy, and those with retinopathy.

• MATERALS AND METHODS : This prospective case-control study was conducted at Departments of Pathology and Ophthalmology, School of Medical Sciences & Research, Sharda Hospital, Greater Noida. Over one and a half years, 150 cases were enrolled, divided into three groups: controls, diabetic patients without retinopathy, and diabetic patients with retinopathy. The patients coming to ophthalmology opd for retina checkup, blood sample was taken. As same vial is used for both estimation of platelet indices and HBA1C, both blood investigations along with their retina findings were noted. Inclusion criteria involved adult type 2 diabetes patients, with exclusions for anemia, certain eye conditions, uncontrolled hypertension, cardiovascular issues, renal failure, anti-platelet drug usage, malignancy, and type 1 diabetes were made.

• RESULTS: The results revealed significant variations among the groups. In controls, the majority (90%) had MPV below 12, whereas in diabetic patients without retinopathy, most (58%) had MPV ranging from 12 to 15. Among diabetic patients with retinopathy, the largest group (38%) had MPV above 15 and 56% had MPV between 12-15 fl. PDW showed similar trends, with 96% of controls having PDW below 17, while 96% of diabetic patients with retinopathy was >20 . PLCR percentages ranged within normal limits for controls but shifted towards higher values in diabetic groups. Platelet counts were consistent between control and diabetic without retinopathy groups, averaging around 252,000 x10^3/cumm, while diabetic patients with retinopathy had a slightly lower average count of approximately 242,000 x10^3/cumm.

INTRODUCTION

DEFINATION AND PROBLEM : Diabetes Mellitus (DM) is a major global health problem.[1]. It is a group of metabolic disorder characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both. [2] Consequential hyperglycaemia causes long term vascular complications and failure of various organs, especially the eyes, kidneys, nerves, heart, and blood vessels[3]. Diagnosis of DM was established using American Diabetes Association criterion of fasting blood glucose level of >=126mg/dl or 2hrs post prandial blood glucose >=140 mg/dl on two occasions or random glucose levels of >= 200 mg/dl or HBA1C of>= 5.6 [3]

EPIDEMIOLOGY: According to World Health Organization (WHO) the number of people with diabetes has risen from 108 million in 1980 to 422 million in 2014. [1] It is projected that by year 2025, 80.9 million will have diabetes in India[2]. Diabetic Retinopathy (DR): is one of the most important complications and leads to considerable increase in morbidity. [4] Retinopathy is defined as presence of at least 2 microaneurysms and or retinal haemorrhage, DR, the most common retinal vascular disease, is the leading cause of new blindness in adults during the third through sixth decade of life.

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PLATELET PARAMETERS: Platelet parameters like MPV, PWD, Plateletcrit (PCT), Platelet large cell ratio and platelet count are easily available [7] and are an important and easily accessible indices done in routine blood test, that reflect the size and activity of platelets.[22] .

As DM is considered as a “prothrombotic state” , altered platelet morphology and function has been observed in diabetes in the form of enhanced platelet activity . If microvascular complications like DR are detected at the earlier stages it will be useful in controlling them and protecting the patients from associated adverse events. Platelet volume indices (PVI) such as MPV, PDW, PLCR, PC are cost effective, easily available and more compliant and can be the potential biomarkers for DR . [43]

MATERIALS AND METHODS

Source of Data

The study was carried out in the Department of Pathology in collaboration with Ophthalmology Department, School of Medical Sciences & Research, Sharda University and Sharda Hospital, Greater Noida.
Study Period –One and a half year
Sample Size–50 cases
Study Design – Prospective Case-Control Study
Equipments:
• Automated Blood Cell Analyser SysmexXN1000

• Fully automatic Biochemistry analyzer, Vitros 5600 (Johnson & Johnson-USA)

• High performance liquid chromatography (HPLC D10)

• Bio-Rad D10

• Direct ophthalmoscope

• Slit lamp Appasamy Associates Model Aaru-2000

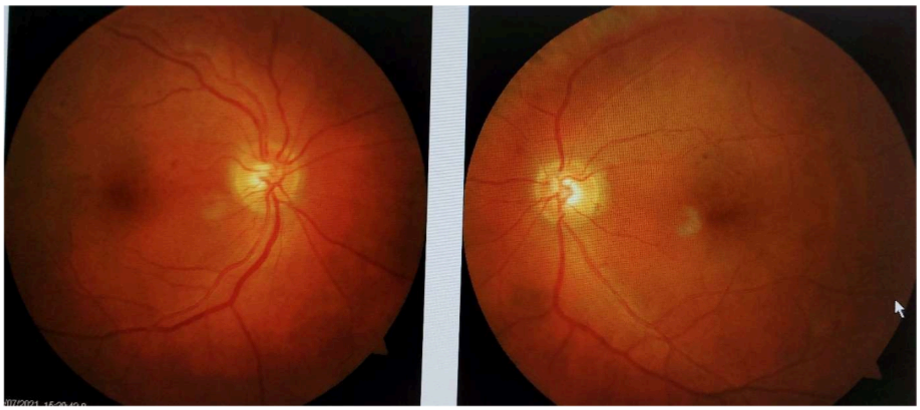
• Fluorescent FFA Zeiss Visu Cam 500

The study will be carried out in the Department of Pathology in collaboration with Ophthalmology at School of Medical Sciences & Research, Sharda University and Sharda Hospital, Greater Noida for a period of one and a half year.

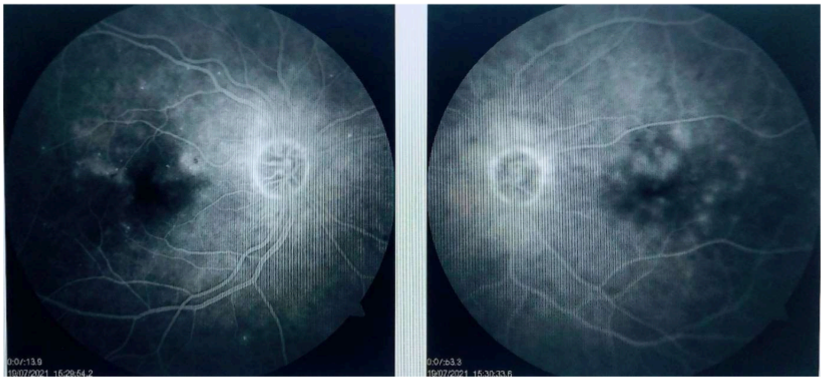
50 normal age and se matched controls were also taken having normal blood sugar levels and HbA1C values.
Another 50 patients were selected from the ophthalmology opd. The patients undergoing retina checkup or already diagnosed cases of diabetes were taken. The patients undergoing retina checkup , blood sample was taken for those patients. As same vial is used for both HBA1C and platelet indices, that is lavender, a single random sample was taken . Also their fundoscopy, optical coherence tomography anf fundus flouroscein angiography was performed. Both blood investagations and fundus findings were noted and correlated.

Image of Case 1 Both eyes moderate NPDR, with diabetic macular edema

Fundus photography



Both eyes: Disc normal, A: V: 2:3, MICROANEURYSMS along with few dot haemorrhages seen, foveal reflex blunted

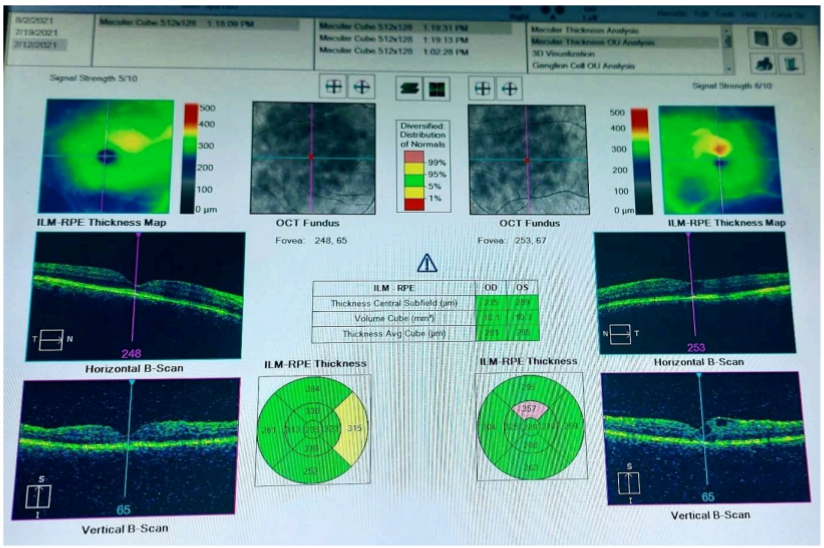


FFA s/o

RE: multiple hyperfluorescent lesions seen in all 4 quadrants in early phases s/o microaneurysms, with extrafovealhyperfluorescent lesions showing increase in size and intensity in late phases of angiogram s/o leakage (leaking microaneurysms depicting macular edema)

LE : multiple hyperfluorescent lesions seen in all 4 quadrants in early phases s/o microaneurysms, with juxtafoveal and extrafovealhyperfluorescent lesions showing increase in size and intensity in late phases s/o leakage (LE>>RE) (leaking microaneurysms depicting macular edema)

OCT



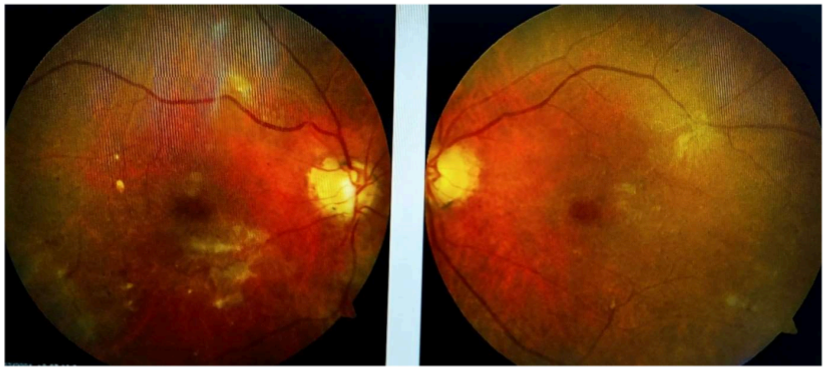
RE : s/o Non Centre Involving Diabetic Macular Edema (Non CI-DME), Central sub foveal thickness : 235 microns

LE: Cystoid intraretinal spaces seen mainly superior to fovea and also subfoveally s/o Centre Involving Diabetic Macular Edema (CI- DME) , Central Subfoveal Thickness (CSFT) : 290 microns.

Same patient had MPV 14.5, PLCR 55.2 , PDW 24.5, and HBA1C of 10.8, average blood glucose of 250, platelet count 236.

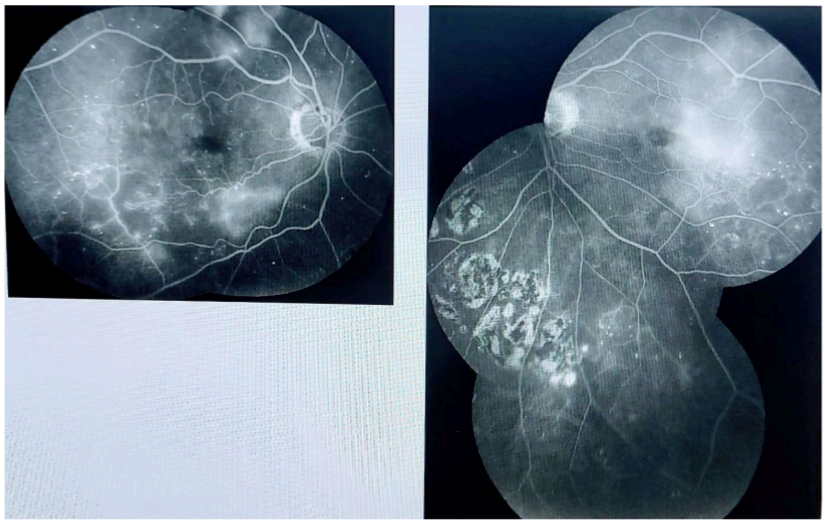
Pt2 partially lasered PDR with DME (LE>RE)

Fundus Photography:



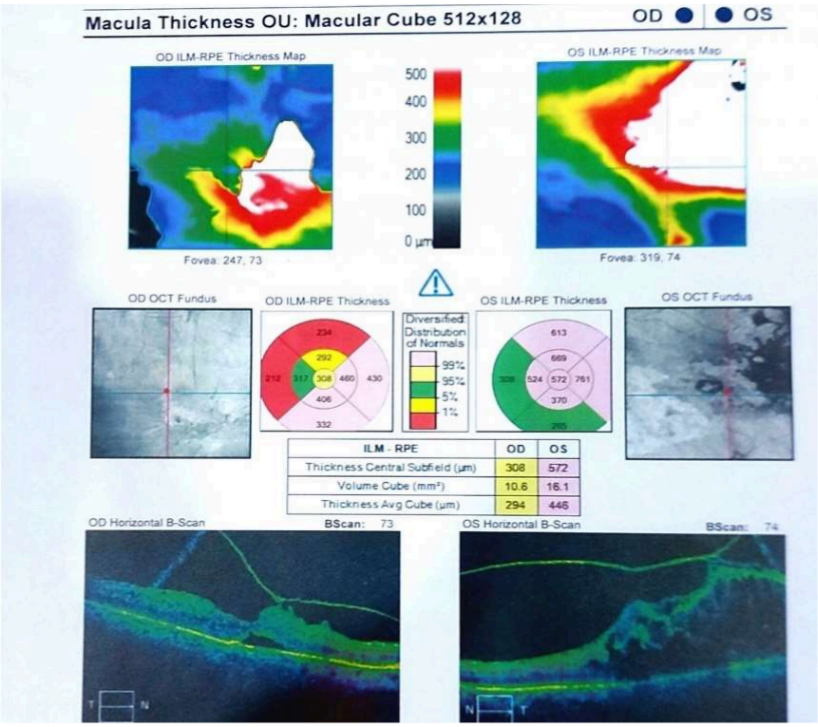
RE: Cup Disc Ratio (CDR): 0.9, A:V:: 2:3, Scattered laser scars (PanRetinal Photocoagulation) seen beyond temporal arcades , FVP (Fibrovascular proliferation) seen inferonasal to fovea , with hard exudates temporal to fovea and blunted foveal reflex, s/o Partially lasered PDR.

LE: Cup Disc Ratio (CDR) : 0.9, A:V:: 2:3, Scattered Laser scars seen beyond arcades, FVP seen along Superotemporal arcade, blunted foveal reflex s/o Partially lasered PDR.



FFA RE : Neovascularisation elsewhere (NVEs) seen along temporal arcades, with few capillary dropout areas/ capillary non perfusion areas (CNP) , with staining of laser scars in inferior midperiphery. Mild late macular leakage seen .

LE: staining of laser scars seen inferiorly . No NVD (Neovascularisation at Disc)/NVE noted. Temporal diffuse macular leakage seen in late phases of angiogram, with few CNP areas.

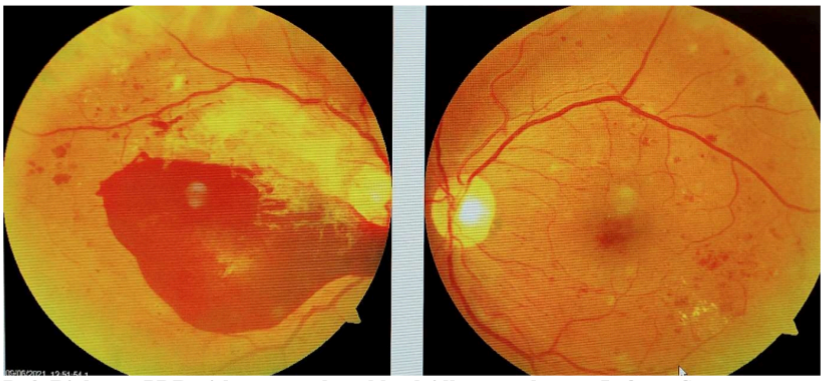


OCT

RE: Focal ParafovealVitreomacular Traction (VMT) , with shallow subfoveal Neurosensory detachment (NSD), CSFT : 308 Microns s/o CI- DME

LE: Focal Parafoveal VMT , with cystoid macular edema (CME) mainly temporally, reaching upto the centre . CSFT : 572 microns, s/o CI-DME

Same patient had MPV 17, PLCR 57, PDW 26, Platelet count 258, HBA1C of 11.1



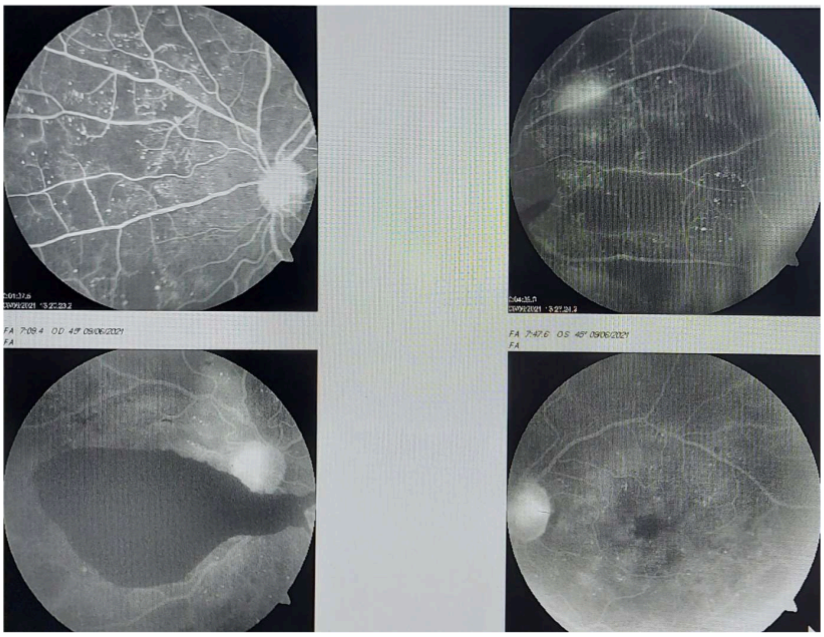
Pt 3 Right eye PDR with premacularsubhyaloidhaemorrhage. , Left eye Severe

NPDR.

Fundus Photograph :

RE : Disc normal, A:V::2:3, multiple microaneurysms and dot-blot haemorrhages seen, fibrous proliferation seen beneath Superotemporal arcade, with a large subhyaloidpremacularhaemorrhage (approx. : 8 Disc Diameter in size) , s/o Proliferative Diabetic Retinopathy

LE : : Disc normal, A:V::2:3, multiple microaneurysms and dot-blot haemorrhages seen with few exudates in the background. No NVD/NVE seen clinically. Blunted foveal reflex seen

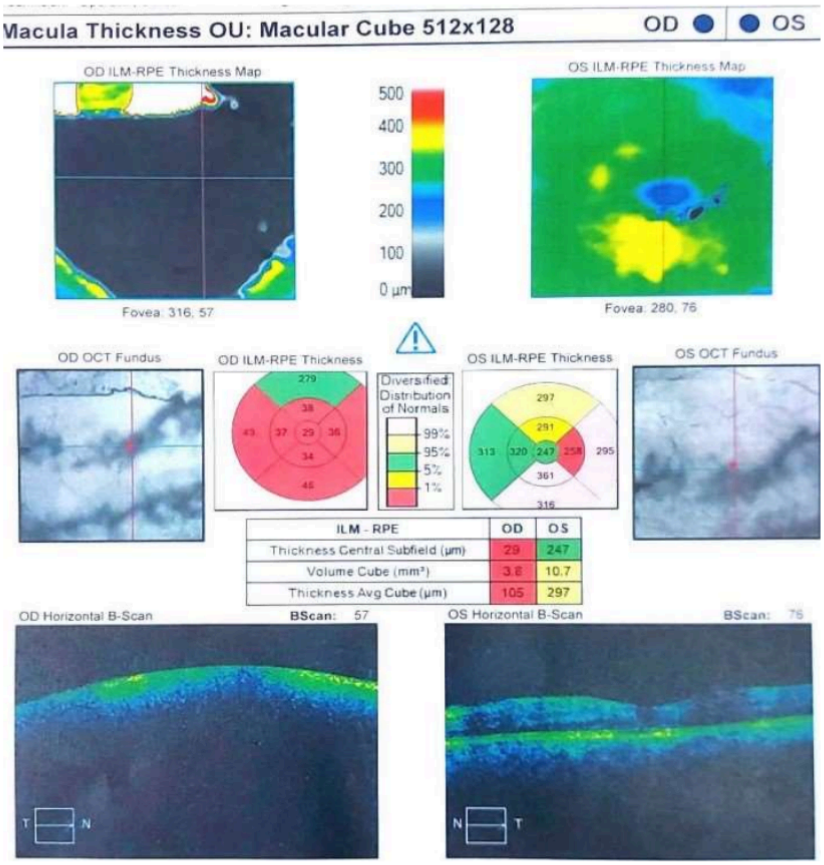


FFA

RE: Leakage seen from NVE nasal to disc, with multiple CNP areas, s/o PDR, with blocked fluorescence at macula d/t Premacularhaemorrhage

LE: Multiple CNP areas seen nasally, with mild diffuse leakage at macula in late phases of angiogram. No NVD/NVE seen.

Oct


Macula Thickness OU: Macular Cube 512x128
OD
OS
OD ILM-RPE Thickness Map
OS ILM-RPE Thickness Map
500
400
300
200
100
0 µm
Fovea: 316, 57
Fovea: 280, 76
OD OCT Fundus
OD ILM-RPE Thickness
279
38
43
37
29
36
34
46
Diversified Distribution of Normals
99%
95%
5%
1%
OS ILM-RPE Thickness
297
291
313
320
247
258
295
361
316
OS OCT Fundus
ILM - RPE
OD
OS
Thickness Central Subfield (µm)
29
247
Volume Cube (mm³)
3.8
10.7
Thickness Avg Cube (µm)
105
297
OD Horizontal B-Scan
BScan: 57
OS Horizontal B-Scan
BScan: 76
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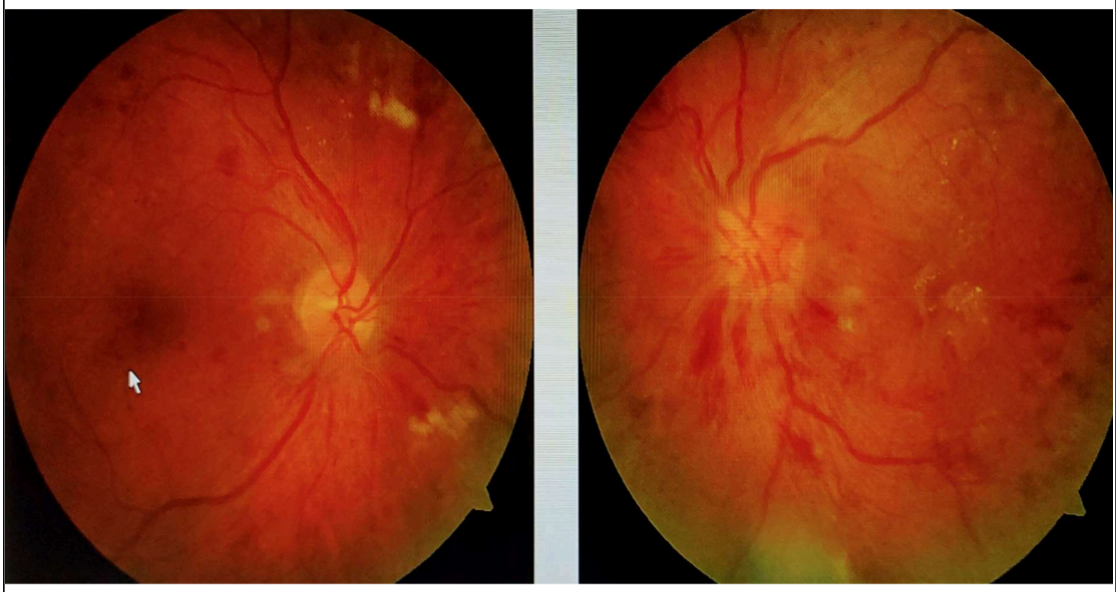
OCT

RE: Hyperreflectivity seen anterior to macula with posterior shadowing s/o premacularsubhyaloidhaemorrhageLE: CSFT : 247 micron . Parafoveal spongiform edema seen superiorly and inferiorly (Inferior >> superior), s/o Non CI DME

Same patient had MPV 22, PLCR 54, PDW 27, Platelet count 309 on high range.

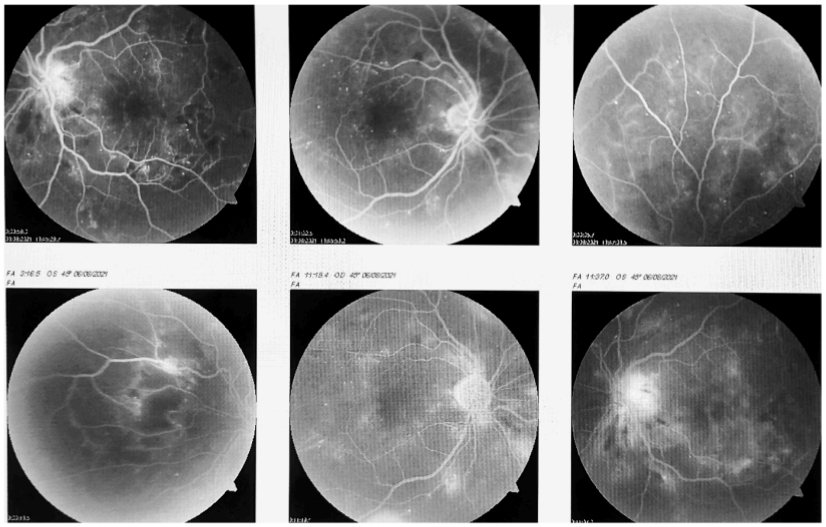
Pt 4 60 Yrs severe NPDR, macular edema, disc edema



Fundus photography :

RE: Disc normal, A:V::2:3, multiple microaneurysms with peripapillary cotton wool spots seen (soft exudates) , with blunted foveal reflex. No NVD/NVE seen clinically.

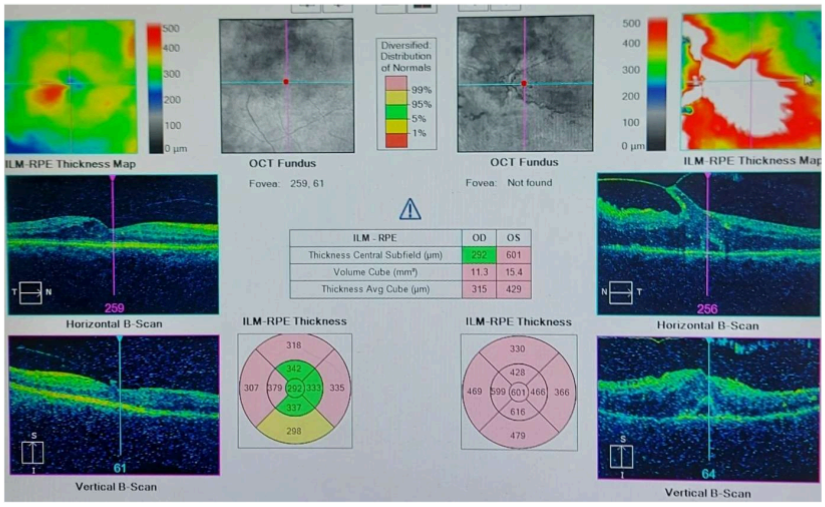
LE: Disc margins blurred s/o disc edema, A:V:: 2:4, with mild dilatation and tortuosity of retinal veins, with both superficial and dot blot retinal haemorrhages, with few hard exudates seen at macula . No NVD/NVE seen clinically.



RE : Multiple leaking microaneurysms with few CNP areas, No NVD/NVE noted

s/o NPDR. Mild late macular leak seen d/t leaking microaneurysms.

LE: Multiple leaking microaneurysms with massive CNP areas seen in mid periphery and periphery with doubtful NVE nasal to disc, with Disc Leak , likely PDR with Diabetic papillopathy. Diffuse late macular leakage seen.

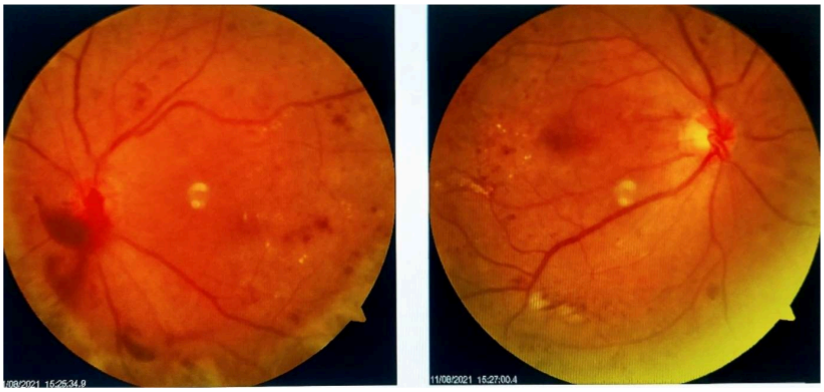


RE: Parafoveal Cystoid macular edema seen . CSFT : 292 microns , s/o Mild CI-DME.

LE: Focal VMT , with globally adherent Epiretinal membrane (ERM), with spongiform macular edema with shallow subfoveal NSD. CSFT : 601 Micron , s/o Tractional CI-DME.

Same patient had MPV 19, PLCR 56, PDW 24, Platelet count 315 which correlated with retinopathy findings as they were on higher limits.

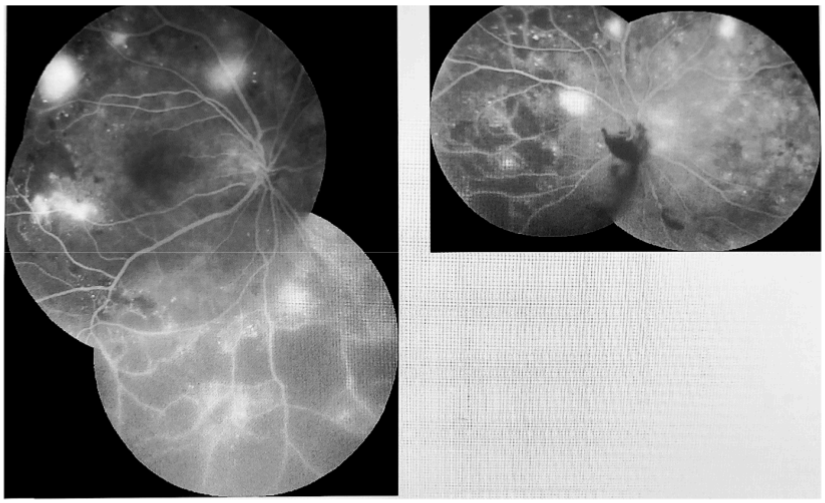
Pt 5 Both eyes PDR, with DME



Fundus Photography

RE : Multiple microaneurysms with dot blot retinal haemorrhages , and hard exudates temporal to fovea, seen on fundus photography . Flat network of vessels, likely NVEs seen .

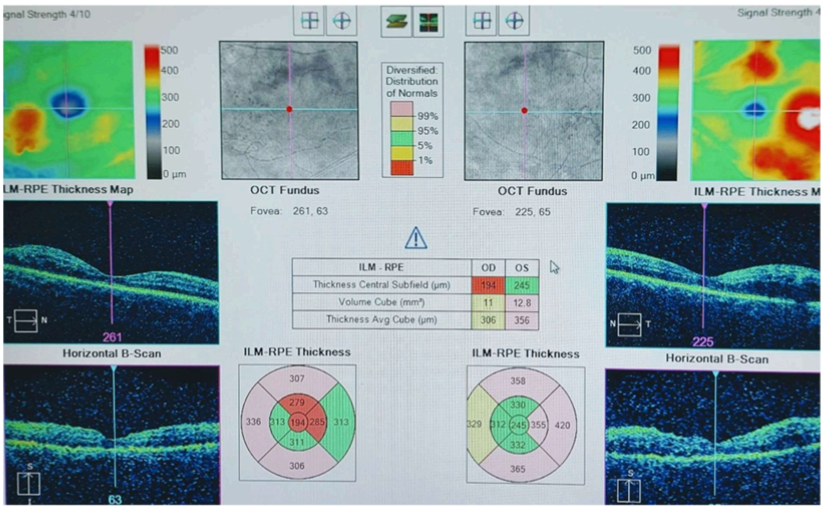
LE: Background changes of diabetic retinopathy, with Vitreous Haemorrhage (overlying the optic disc and inferiorly) .



FFA

RE : Multiple hyperfluorescent lesions with profuse leakage in late phases , s/o NVEs seen , along with significant CNP areas. There is enlargement of foveal avascular zone (FAZ), s/o Macular Ischemia.

LE: hyperfluorescent lesions with profuse leakage in late phases , s/o NVEs seen , along with significant CNP areas in nasal quadrant. There is blocked fluorescence overlying the Optic Disc and inferiorly (due to Vitreous Haemorrhage). The Macula shows diffuse leakage in the late phases.



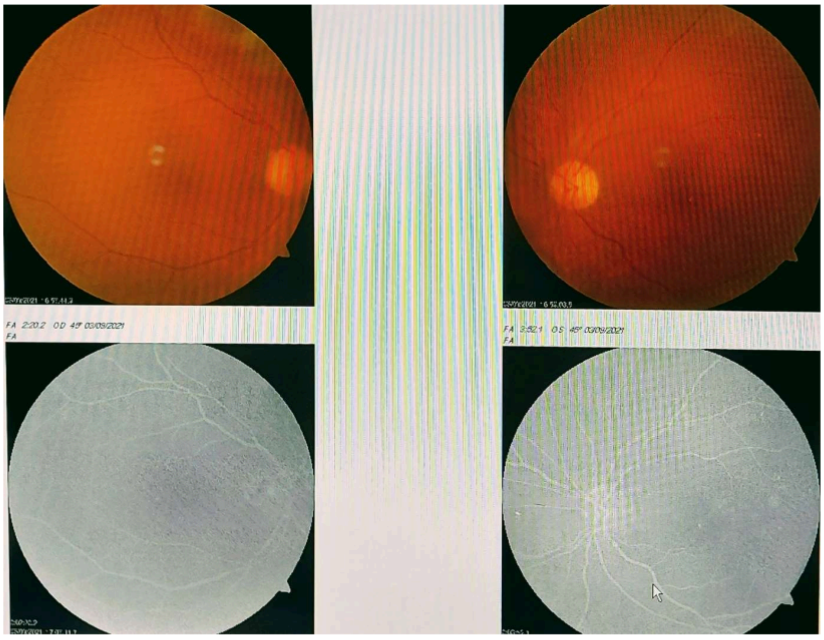
OCT

RE: Foveal Thinning with mild parafoveal spongiform edema (mainly temporal and inferior to fovea) . CSFT : 194 microns, s/o Foveal Thinning with non CI-DME.

LE: Parafoveal spongiform edema (mainly temporal and inferior to fovea, and mild edema superior to fovea) . CSFT : 245 microns, s/o Non CI DME.

Same patient had MPV 22, PLCR 57, PDW 20, Platelet count 322 ,HBA1C 12.5 correlated with retinoscopy findings.

Pt 6 70 yrs, Moderate NPDR, with DME.



Fundus photography

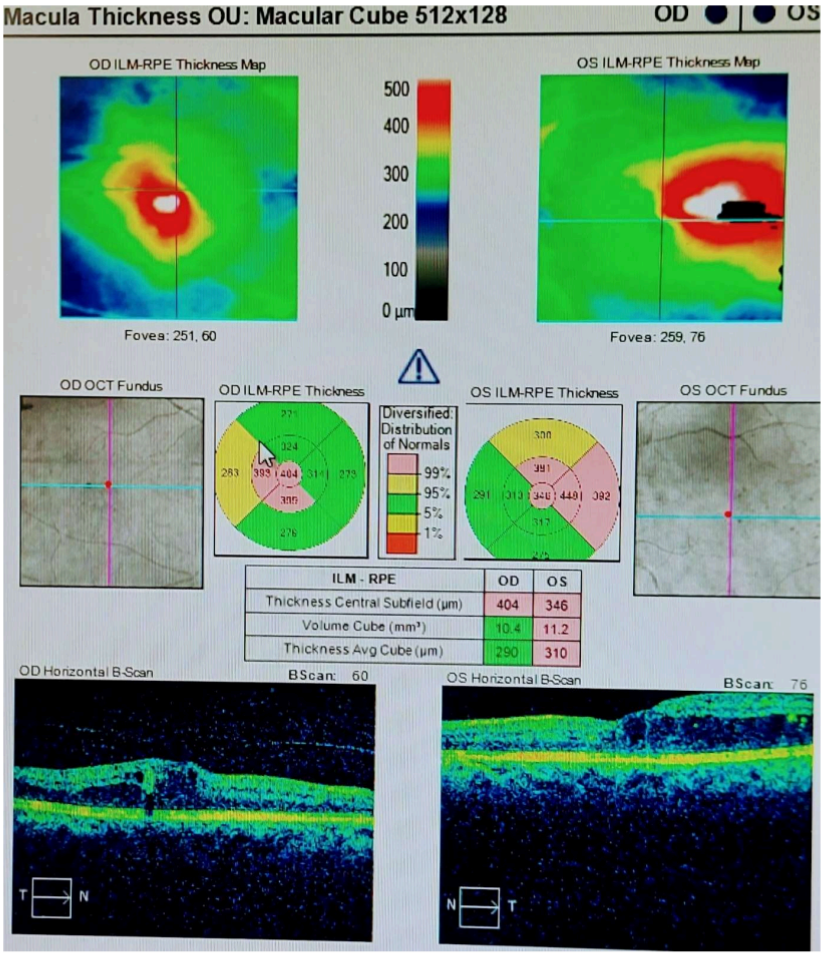
RE: Disc normal, A:V::2:3, Microaneurysms with retinal haemorrhages seen. (Note : the hazy pictures are due to cataract). Foveal reflex is blunted.

LE : Disc normal, A:V::2:3, Microaneurysms with retinal haemorrhages seen. (Note : the hazy pictures are due to cataract LE<RE). Foveal reflex is blunted

FFA

RE: Hazy media with hyperfluorescent lesions s/o Microaneurysms. Macula details are hazy d/t cataract.

LE: Hazy media with hyperfluorescent lesions s/o Microaneurysms, seen. Mild leakage at macular region seen hazily.



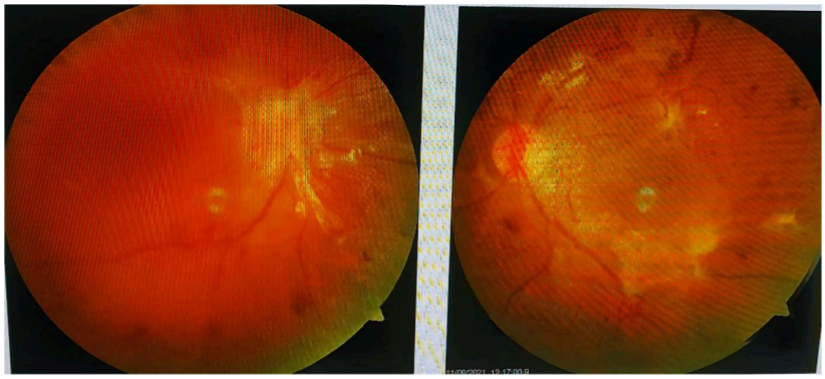
OCT :

RE: Blunting of foveal contour with retinal thickening with intraretinalhyporeflective spaces, s/o Cystoid macular edema . CSFT : 404 microns (CI-DME) LE: Blunting of foveal

contour with retinal thickening with intraretinalhyporeflective spaces, mainly temporally s/o Cystoid macular edema . CSFT : 346 microns (CI-DME)

Same patient had MPV 28, PLCR 7, PDW 8, Platelet count 225 which were high in diabetic retinopathy patients.

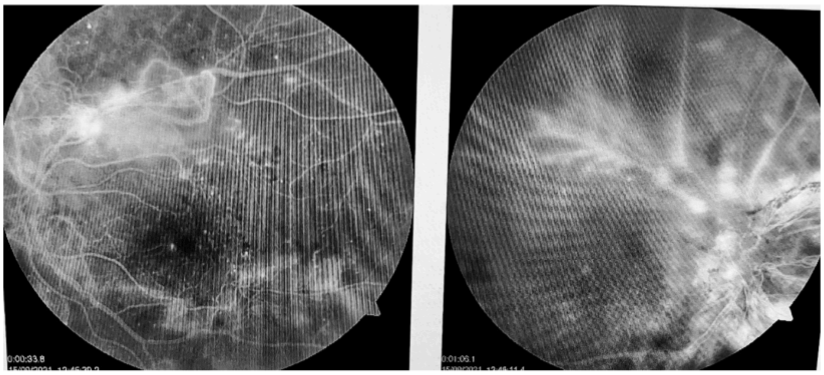
Pt 7 LE PDR with RE VH



Fundus Photograph

RE: Mild dispersed intragel Vitreous Haemorrhage (VH) seen, with FVP at the disc. Macula details hazy due to overlying VH

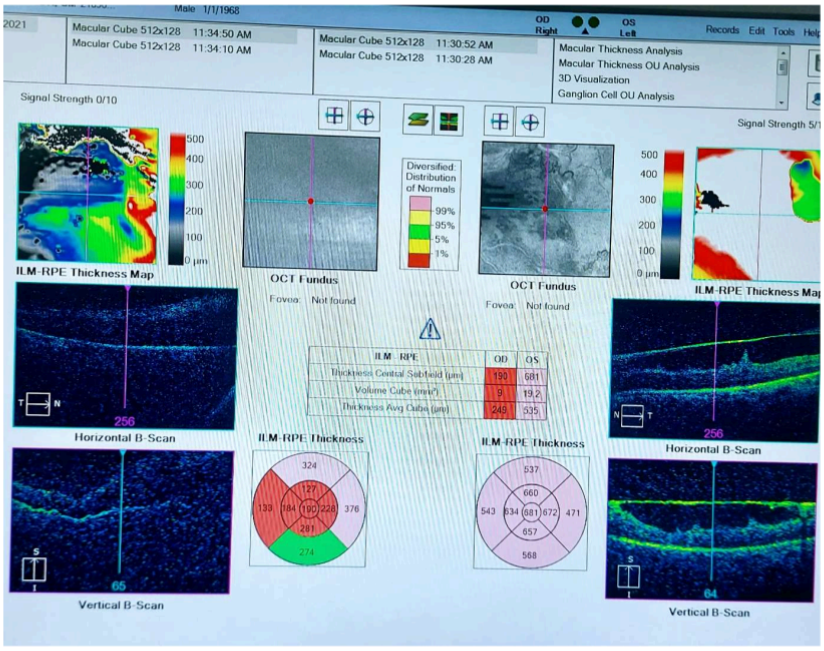
LE: Microaneurysms, scattered dot blot haemorrhages, seen in addition to FVPs along temporal arcades.



FFA

RE: Media haze d/t VH, diffuse leak at Disc s/o NVD , with late staining of vessel walls seen.

LE: Large neovascular fronds (NVEs) seen along temporal arcades, with enlagement of FAZ, with scattered Capillary drop out (CNP) areas.



OCT

RE : Retinal Scans hazy due to VH , there is diffuse thickening at macula (grossly) s/o DME

LE: Taut thickened posterior hyaloid with traction along Superior and inferior arcade, with macular thinning along with disorganization of outer retinal layers, s/o ischemic maculopathy .

Same patient had MPV 29, PLCR 9, PDW 25, HBA1C 11, Platelet count 278, which were high in retinopathy patients.

DISCUSSION

The study was carried out in the Department of Pathology in collaboration with Ophthalmology Department, School of Medical Sciences & Research, Sharda University and Sharda Hospital, Greater Noida.

2 groups were made, controls, and diabetic with retinopathy, each comprising of 50 patients each. Their platelet indices were tested along with ophthalmological examination and compared.

This study was carried out in the Department of Pathology in collaboration with Ophthalmology Department, School of Medical Sciences & Research, Sharda University and Sharda Hospital, Greater Noida.

100 cases were included in the study. These cases were divided into 2 groups namely controls and diabetic with retinopathy, each comprising of 50 patients each. These patients underwent a detailed ophthalmological examination. Subsequently platelet indices were tested in each case and comparison was drawn among the groups. The patients coming to ophthalmology OPD for retina check up, were counselled to give blood sample also. Blood sample was taken in EDTA vial, also same vial is used for both HBA1C and platelet parameters. The diabetic patients were taken from both medicine and ophthalmology OPD. Controls were selected from random healthy individuals like author itself, teachers and students.

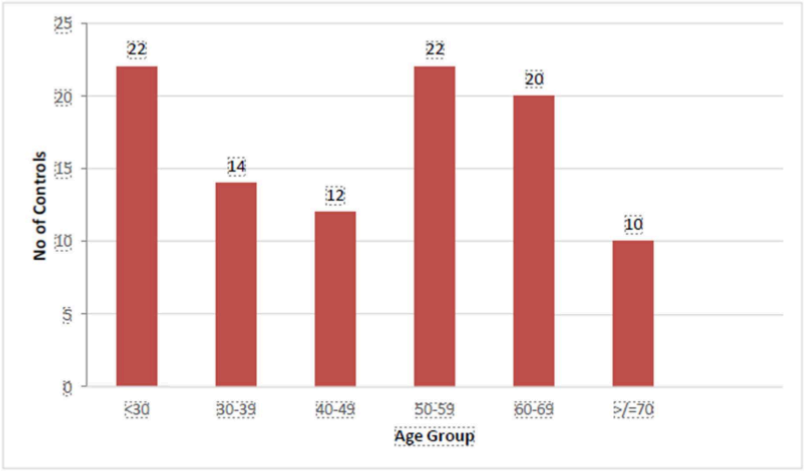
RESULTS

1. Age
A) Control

We also calculated average and standard deviation. We found that the. Average age in control group was
47.36 years. Range was about, 20 to 78 years and Standard Deviation for age was 17.4154 years.

Table No. 1 Distribution of controls according to age Age group (years)	No of controls (n)	Percentage (%)
< 30	11	22
30-39	07	14
40-49	06	12
50-59	11	22
60-69	10	20
>/=70	05	10

Bar Diagram No. 1



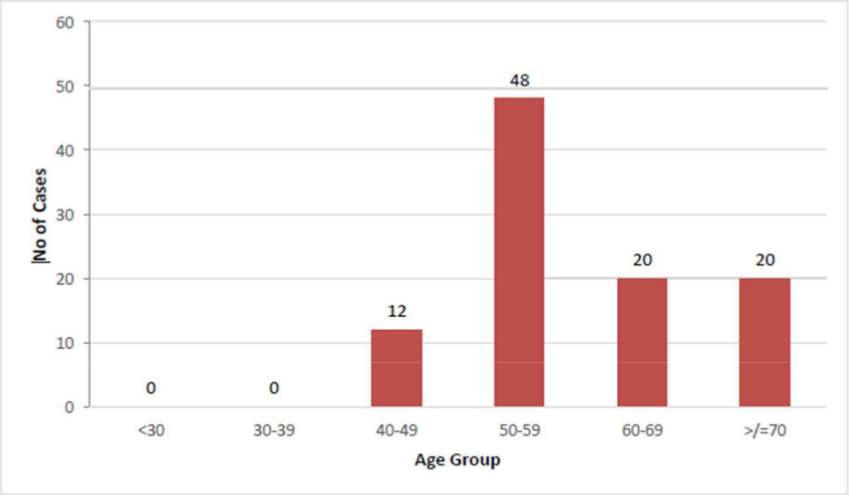
Out of 50 cases of controls the maximum number of cases (n=11, 22%) were in age groups 50-59years and <30years each; followed by (n=10,20%) cases in 60-69 years age group. The minimum number of cases (n=5, 10%) were noted in </=70 years age group.

Age Group

Distribution of Diabetes with Retinopathy according to age We calculated age diversification of 3rd group.

We calculated that average/mean age for diabetic with retinopathy was 58.54 years range was

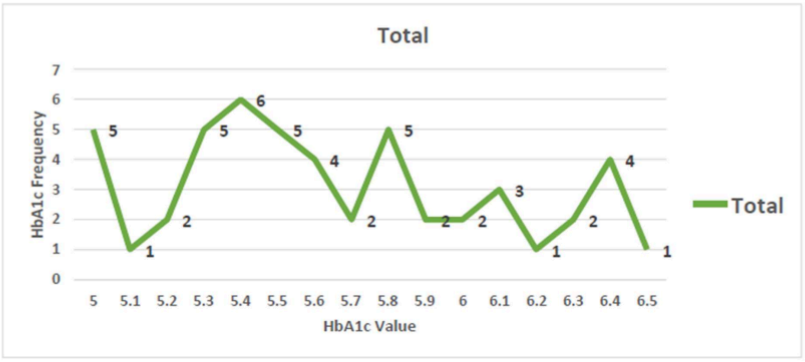
40- 78 years Age group	No of cases	Percentage (%)
< 30	00	0
30-39	00	0
40-49	06	12
50-59	24	48
60-69	10	20
>/=70	10	20



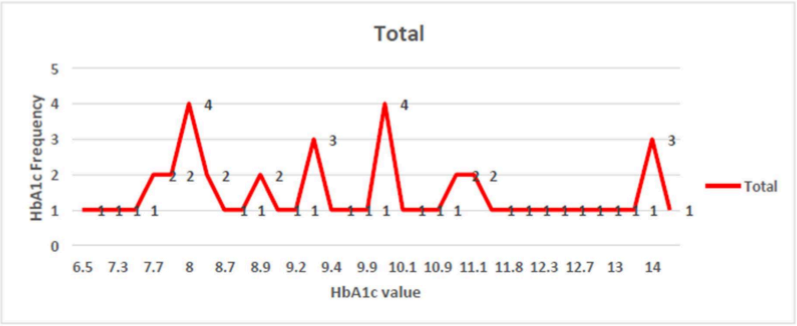
C) HBA1C

We calculated average, range & Std. deviation & frequency of HBA1C also in 2nd group.

Distribution of cases according to HbA1C in controls



Distribution of cases according to HbA1C in Diabetic Retinopathy



a) Control-Average/ mean HBA1C was 5.6 in control group and range was 5 to 6.5, and std deviation was - 0.432

b) DM with Retinopathy -Average 10.07, Range was 5.1- 15 and Std. deviation was 2.12

DISCUSSION

In our study, it was found that the age of the cases without retinopathy ranged from 25-75 years (mean 54.4 ±11.012 years) while cases with retinopathy ranged from 42-78 years (mean 58.5 ± 9.9 years). The age of controls ranged from 20-78 years (mean 47.3 ±17.4 years). The study by Jee et al in South Korea showed the similar age group in cases with retinopathy with the mean age group of 58.0 +/- 11.6 years. [52]

In a study by Ramappa et al showed range of DR patients (100) from 40 to 77 years with a mean of 54.01 ± 7.94 (SD). This similarity with our study was due the similar sample size. [54]

In a study by Medeiros et al where the study was conducted in population of Portugal, showed the mean age of DR as 69.1+/-11.1years. [53] This slight difference in mean ages was due to their large sample size.

In the present study there were equal of males and females, 25 cases each in the patients without retinopathy while there was male predominance with 35 cases in patients with retinopathy. However in controls there were 29 males and 21 females. In a study by Ramappa et al the study group had 65 males (65%) and 35 females (35%) The findings were concurrent with the present study. Which showed male predominance. [54]

In the present study in the patients without retinopathy the HbA1C ranged from (5.1 -15.0 %) with (8.5± 2.07) while patients with retinopathy it was (5.1 -15.0 %)

with (2.12± 10.07) with mean HbA1c of 10.07. However, in controls it was (5.0-6.5 %) with (5.6± 0.43%). In another by Sadhana S et al it was reported that there were (69%) of DR patients had Hba1c of > 8%. The findings were concurrent with our study. [55]

It is due to the fact that retinopathy progresses with poor glycemic control.

It was found that in our study, MPV was significantly higher in diabetics with retinopathy (16.26 +/- 4.89 fl) as compared to the healthy controls (11.75 +/- 1.97 fl) (p value=0.0001). Few independent studies show concordant results with the findings of our study. A study by Thomas Alex Kodiatte, Udaya Kumar Manikyam et al, showed MPV of 11.31 in DR patients and 9.91 in controls with p value <0.001. [10]

In a similar study conducted by Citrik, MPV was higher in DR group 8.05 fl than controls having MPV of 7.74 fl, p value of <0.01. [5]

In a meta-analysis by Ji S et al showed higher MPV in diabetic retinopathy group than non-diabetic group. [57] Another study by Zuberi BF et al it was reported that the MPV in the diabetic with retinopathy group was 9.34 fl and controls was 8.63 fl was statistically significant (p<0.01). [56] Mukund W. Pujari et al showed MPV was significantly higher in diabetes with retinopathy as compared to controls was 9+/-0.9 fl and 8.08 +/-0.45 fl with p value <0.0001. [2]

Similarly, in the study by Hekinsoy et al it was found MPV was significantly higher and were significantly lower in diabetes with retinopathy compared to age and sex-matched non-diabetic healthy controls. [51]

Navya BN et al MPV was significantly increased in diabetes with retinopathy (8.83+/- 0.72fl) when compared to healthy controls (7.62+/-0.47 fl) with (p = 0.001.). [23]

Xiangyu et al showed MPV was significantly higher in the subjects with diabetes with retinopathy vs controls. (9.30 vs. 9.20 fL) (p<0.01). Swaminathan et al in their study reported that MPV was 9.816±0.4 fl and 10.2±0.77 fl in controls and diabetics with retinopathy (p= 0.023). [24]

ArchanaBuch et al carried out a study in the patients with diabetes with complication and found MPV was 11.31fl and controls was 9.91fl (p <0.0001), statistically significant. [32]

In our study MPV was (16.26 +/- 4.89 fl) in diabetics with retinopathy as compared to (12.75 +/-1.97 fl) in diabetics without retinopathy (p value=0.0001). But there was no statistically significant relation between platelet counts between these groups (p value< 0.45). LeventDemirtas et al carried out a study in 67 patients with retinopathy and 240 patients without retinopathy. It is found that MPV=9.54±0.88 in diabetics with retinopathy and MPV=9.20±0.92 in diabetes without retinopathy (P=0.006), while the remaining other studied haematological indices were not differ statistically (P > 0.05). [58]ShubhrathasHegde et al in their independent study showed that there is a statistically significant relation of MPV between diabetics and diabetics with complications. MPV was 8.89+/-0.73 fl in diabetic retinopathy group and 8.04+/-0.78fl without retinopathy group with p value of 0.016, statistically significant. [59]

Li Z et al showed that females with MPV >/= 9.80 fl had 92% increased incident risk of diabetes mellitus compared with those who had MPV <7.50 fl (p = 0.002)

in type 2 Diabetes mellitus risk. However no such association was seen between gender and MPV in our study. The reason for this could be a large population base and a different ethnicity. [60]

In our study we found that MPV and HbA1C (8.7+/- 0.8 fl vs 8.2+/- 0.7fl) (r= 0.39, p=0.001). Demirtunc et al expressed significant direct correlation between MPV and HbA1C (8.7+/- 0.8 fl vs 8.2+/- 0.7fl) (r=0.39, p=.001), concurrent to findings of our study. [21]

However, in a study by Sonali Jindal et al, the MPV was 12.25fl in diabetics with complications and 11.77 fl without complications, and the p value was not statistically significant (p= 0.212). The reason may be a due to a small sample size. [44]

Minle Wu et al reported that PDW levels were significantly higher in the HbA1c subgroup (≥ 6.5%) than that in HbA1c lower subgroup (< 6.5%) (p < 0.01). PDW was 13.8 fl in diabetics and 12.5 fl in non-diabetics with (p =0.012). These results coincided with our study with PDW of 18.25 +/- 4.3% % fl in diabetics and 13.30 +/- 2.3% fl in non-diabetics. [39]

Our study showed statistically significant values of PDW 21.79 +/- 4.04% in cases with retinopathy vs. 18.25 +/- 4.3% in cases without retinopathy. Which coincided well with the study conducted by Ji S etal. [57]

Akinbami A et al reported that the mean platelet count for the diabetics with retinopathy was 235.29 ± 76.81 $x10^9$/L and controls, 211.32 ± 66.44 $x10^9$/L. The study revealed a higher mean platelet count for diabetes with retinopathy on treatment than for non-diabetic controls. There was a statistically significant difference in platelet counts of diabetics and healthy controls (p =0.038). However in our study the mean platelet count was 242.24 $x10^3$ /cumm cases with retinopathy

252.68 x10^3 /cumm in cases with retinopathy and 252.74 x10^3 /cumm in non-diabetics i.e. controls. There was no statistical difference between the results of each group. The difference in this study could be a different method for analysis and a specific ethnic population. [20]

PLCR in our study was found 51.35 +/- 8.2% in cases with retinopathy and 13.63 +/- 8.32% in control group.

TanimaDwivedi et al noted that platelet-large cell ratio (PLCR) was 24.6±6.77, 36.9±6.80 in patients controls and with diabetic retinopathy ($p < 0.001$). [61]Minle Wu et al P-LCR was positively correlated with HbA1c levels ($p < 0.01$). The results these independent studies were consistent with results of our study. [39]

• CONCLUSION: The study concludes that MPV, PDW, and PLCR could potentially serve as cost-effective, easily available, better compliant and can serve as a novel biomarkers for assessing the progression of diabetic patients toward retinopathy. Many Platelet targeting drugs can also be developed for better treatment of DR. However, further studies are necessary to validate these findings and establish their clinical utility.

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PLATELET INDICES: INDICATORS OF DIABETIC RETINOPATHY

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