A Dissertation on

A CLINICAL STUDY OF CORRELATION OF BIOCHEMICAL INDICES INCLUDING HDL_2/HDL_3 RATIO WITH DIABETIC RETINOPATHY SEVERITY STATUS

Submitted to

THE TAMIL NADU Dr. M.G.R. MEDICAL UNIVERSITY

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With fulfillment of the regulation

for the award of the degree of

M.S.. (OPHTHALMOLOGY)

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CERTIFICATE

This is to certify that **Dr. Anupam Yadava,** Post Graduate student in M.S Ophthalmology, at Regional Institute of Ophthalmology and Government Ophthalmic hospital attached to Madras Medical College, Chennai, carried out this dissertation on **"A STUDY OF CORRELATION OF BIOCHEMICAL INDICES INCLUDING HDL_2/HDL_3 RATIO WITH DIABETIC RETINOPATHY SEVERITY STATUS"** under my direct guidance and supervision during the period from May 2006 to March 2009.

This dissertation is submitted to the TamilNadu Dr.MGR Medical University, Chennai in partial fulfillment of award of M.S. Degree in Ophthalmology.

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DECLARATION

I, **Dr. Anupam Yadava,** solemnly declare that the dissertation titled **"A STUDY OF CORRELATION OF BIOCHEMICAL INDICES INCLUDING HDL_2/HDL_3 RATIO WITH DIABETIC RETINOPATHY SEVERITY STATUS"** has been prepared by me. This is submitted to The Tamil Nadu Dr. M.G.R. Medical University, Chennai, in partial fulfillment of the requirement for the award of M.S. Ophthalmology, degree Examination to be held in March 2009.

Place: Chennai

Date:

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CONTENTS

INTRODUCTION

Diabetes mellitus (DM) is group of metabolic disorders that share the common phenotype of hyperglycemia caused by complex interaction of genetic and environmental factors and life style choices. Hyperglycemia can occur due to decreased insulin secretion, decreased glucose utilization and increased glucose production. The metabolic dysregulation associated with DM causes secondary pathophysiological changes in multiple organ systems. It's a leading cause of end stage renal disease, nontraumatic lower limb amputation and adult blindness.

DM is classified according to the pathogenic process that leads to hyperglycemia into two broad categories type 1 and type 2. In type 1 DM there is autoimmune destruction of beta cells in pancreas leading to insulin deficiency. Type 2 is characterized by varying degrees of insulin resistance, decrease in insulin production and increase in glucose production. Type 1 usually develops before the age of 30 years while type 2 develops with increasing age. (But 5-10% of cases diagnosed after 30 years of age have immune destruction of beta cells and type 2 can also occur in children especially obese adolescents). Approximately 10% of diabetic population has type 1 DM and majority belong to type 2.

Chronic complications of DM affect many organ systems. These can be classified as vascular and nonvascular complications. Vascular complications can be further classified as microvascular and macrovascular.

Microvascular complications:

a. Diabetic retinopathy
b. Nephropathy
c. Neuropathy: Sensory, motor, autonomic.

Macrovascular complications:

a. Coronary artery disease
b. Peripheral vascular disease
c. Cerebrovascular disease

Nonvascular complications:

a. Gastrointestinal: Gastrointestinal paresis, diarrhea
b. Genitourinary: Uropathy, sexual dysfunction
c. Dermatological
d. Infectious
e. Cataract
f. Glaucoma.

Microvascular complications are caused due to hyperglycemia and it is conclusively proven that if hyperglycemia is well controlled, these complications can be prevented or delayed.

Type 2 DM has a long asymptomatic period, so it can present with these complications.

Diabetic retinopathy (DR) is a highly specific vascular complication of both type 1 and type 2 diabetes mellitus.. After 20 years of diabetes, nearly all patients with type 1 diabetes and more than 60% of patients with type 2 diabetes have some degree of retinopathy.

DR goes through various stages before leading to visual loss. The first clinical signs are microaneurysms. Then slowly it progresses and leads to formation of new vessels in retina which can lead to sight threatening complications like vitreous haemorrhage.

In general, the progression of retinopathy is orderly, advancing from mild nonproliferative abnormalities, characterized by increased vascular permeability, to moderate and severe nonproliferative diabetic retinopathy (NPDR), characterized by vascular closure, to proliferative diabetic retinopathy (PDR), characterized by the growth of new blood vessels on the retina and posterior surface of the vitreous. The severity and progression of diabetic

retinopathy is affected by many factors. Duration of diabetes, glycosylated haemoglobin, type of treatment (insulin treatment versus non-insulin treatment), systolic and diastolic blood pressures and serum creatinine, showed a positive association with retinopathy while body mass index (BMI) showed an inverse association.

REVIEW OF LITERATURE

Diabetic retinopathy is a microvascular complication of both type 1 & type 2 diabetes mellitus. In the eye its effects are seen predominantly in the retina. It causes loss of vision due to intraocular hemorrhage, tractional retinal detachment, clinically significant macular edema, and macular ischaemia. According to one study, yearly incidence of sight-threatening diabetic retinopathy in patients without retinopathy at baseline was 0.3% in the first year, rising to 1.8% in the fifth year, cumulative incidence at 5 years was 3.9%. Whereas for background diabetic retinopathy, rates of progression to sight-threatening diabetic retinopathy in 1 year was 5% and for preproliferative diabetic retinopathy was 15%. Diabetic retinopathy causes damage by formation of advanced glycosylation end products, increased metabolism via sorbitol pathway and more importantly increased metabolism via hexosamine pathway leading to increased production of various growth factors like vascular endothelial growth factor (VEGF).

According to 2004 WHO publication there are 171 million people worldwide who have diabetes mellitus and the figures are likely double by 2030. India has about 31.7 million diabetic patients ranking first in the world. This number is projected to increase to 79.4 million by 2030.

In the Chennai Urban Rural Epidemiology Study (CURES) eye study I, the prevalence of diabetic retinopathy was found to be 17.6%. Another similar study CURES-2 was done to study the association of serum lipids with diabetic retinopathy in urban South Indians—the Chennai Urban Rural Epidemiology Study (CURES) Eye Study—2.

In general, the progression of retinopathy is orderly, advancing from mild nonproliferative abnormalities, characterized by increased vascular permeability, to moderate and severe nonproliferative diabetic retinopathy (NPDR), characterized by vascular closure, to proliferative diabetic retinopathy (PDR), characterized by the growth of new blood vessels on the retina and posterior surface of the vitreous. These new vessels may cause intraocular bleeding or the gliosis associated with them may cause tractional retinal detachment leading to significant visual loss.

The Early Treatment Diabetic Retinopathy Study (ETDRS) classification given by the ETDRS group was a modified Airlie House classification of diabetic retinopathy which was also used in the Diabetic Retinopathy study (DRS). The seven standard photographic fields were used, and the original

standard colour nonsimultaneous stereoscopic photographs were retained. New photographs were added and some additional characteristics were described. The classification was more elaborative and was more standardized which allowed a very little chance of examiner bias. Thus it has gained worldwide acceptance and presently is a standard for classification of diabetic retinopathy. ETDRS was a multicentric, randomized clinical trial basically designed to evaluate argon laser photocoagulation and aspirin treatment in the management of patients with nonproliferative or early proliferative diabetic retinopathy. ETDRS classified diabetic retinopathy into mild, moderate, severe, very severe, early PDR and high risk PDR depending on the characteristic lesions seen.

DIABETIC RETINOPATHY PRVALENCE AND INCIDENCE

Nearly 171 million people worldwide have diabetes. This figure is likely to double by 2030. India holds 31.7 million diabetic patients ranking first in the world. This number is projected to increase to 79.4 million by 2030.

In 2002 DR accounted for about 5% of world blindness amounting to almost 5 million blind. In India, prevalence of DR has been reported to range from 10.5% to 26.2%. It remains a leading cause of new blindness in developed and developing countries between the ages of 20 and 74 years. The increasing incidence of diabetes has caused DR to be included in the “priority list” as a part of “Vision 2020”.

Worldwide Diabetic retinopathy accounts for 5% of total blindness. In the Chennai Urban Rural Epidemiology Study (CURES) eye study I, the prevalence of diabetic retinopathy was found to be 17.6%. A 1996 report from Madurai revealed that of the 1863 new diabetic patients seen at a tertiary centre, 37% had overt diabetic retinopathy[14]. The increasing incidence of diabetes has caused diabetic retinopathy to be included in the priority list as part of vision 2020.

SYSTEMIC FACTORS ASSOCIATED WITH DIABETIC RETINOPATHY

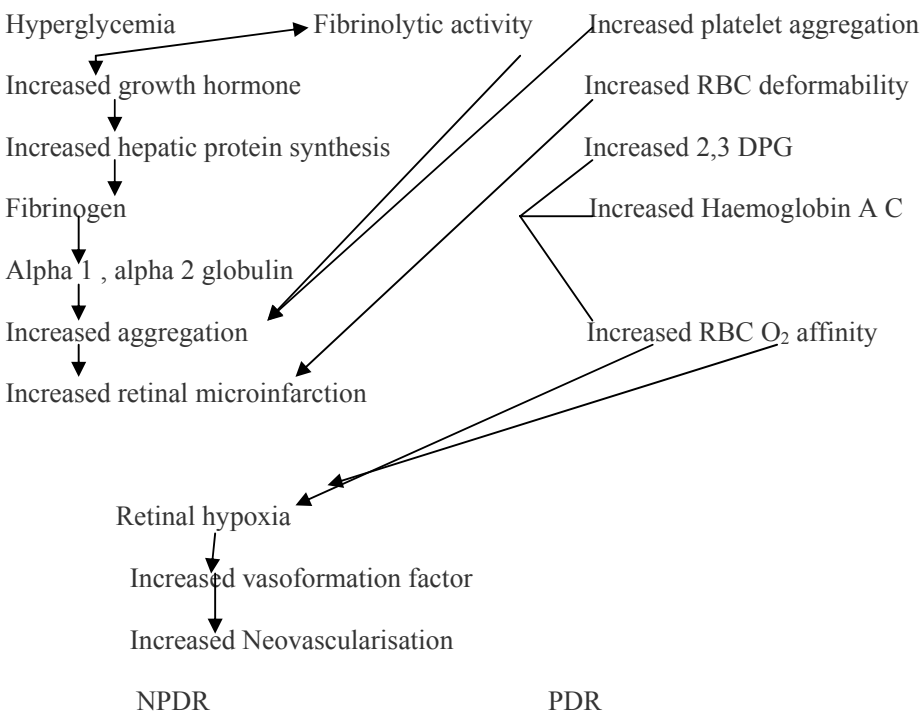
1. One of these is puberty, whether because of the marked hormonal changes that occur at this time or for other reasons.
2. Elevated levels of IGFs may enhance the development of of proliferative diabetic retinopathy ,in particular the rapidly progressive , or "florid", retinopathy that is occasionally seen in young people late in adolescent or in young adulthood.
3. Growth hormone and IGF-1 are probably permissive for the development of retinal neovascularization but are not directly causal.
4. Increased blood pressure and increased blood sugar levels increase the risk for the development and progression of diabetic retinopathy.
5. Unilateral narrowing of the internal carotid artery resulting from arteriosclerosis protected the ipsilateral eye from developing diabetic retinopathy.

PATHOLOGY OF DIABETIC RETINOPATHY

Various mechanisms put forth for the pathogenesis of hyperglycemia induced damage are:

1. Formation of advanced glycosylation end products
2. Increased metabolism via sorbitol pathway
3. Increased metabolism via hexosamine pathway leading to increased formation of fructose 6 phosphate which leads to increased production of various growth factors like vascular endothelial growth factors (VEGF)

SCHEMATIC DIAGRAM OF DIABETIC RETINOPATHY PATHOGENESIS



So one can postulate the following sequence of events in the pathogenesis of diabetic retinopathy:

a. Hyperglyeaernia with insufficient insulin causes an increased output of growth hormone.

b.. Elevated levels_of growth hormone in the presence of reduced levels of insulin alter the hepatic cell synthesis of proteins causing a dvsproteinaemia.

c. Elevated levels of flbrinogen and alpha 2 globulin increase red cell aggregation.

d. Elcvated levels of growth hormone associated with increased production of Von Willebrand factor and reduced levels of prostacvclin increase platelet aggregation.

e. Hyperglycaemia impairs prostacyclin production by endothelial cells. lncreased RBC and platelet aggregation impair haemorheodynamics **in** the microcirculation.

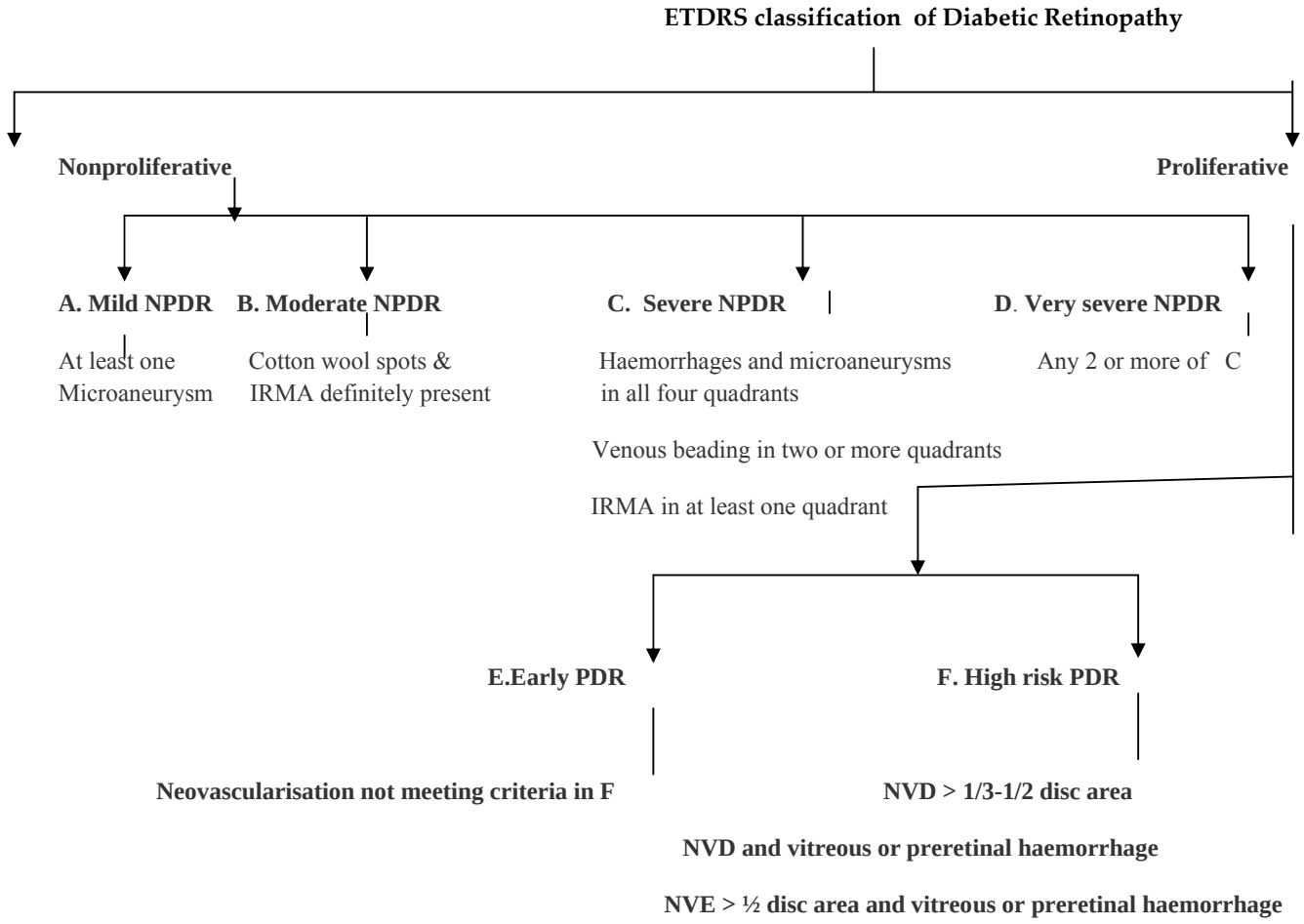
g. Impaired blood flow in the microcirculation by a sluggish flow rate or microinfarction leads to hypoxia and ischaemia.

h. Hypoxia and ischaemia probably cause diabetic retinopathy by the elaboration of a vasoformative factor which stimulates new vessels formation in the optic nerve region or the retina. Hypoxia and ischaemia can cause breakdown and leakage of retinal vessels,massively affect haemodvnamic on

the nature.as well as transudation and exudation of the blood elements into the retinal structures.

PATHOLOGY:

The histological picture of the vessels resemble the arteriosclerotic hypertensive picture.Terminal arterioles reveal hyaline thickening,coiling and narrowing of the lumen.The basement membrane of the capillaries is thickened and there is disappearance of intramural pericytes and endothelial cells.Ghost capillaries may be seen in diabetic retina which are occluded,functionless and these vessels have only thin basement membrane and possess neither pericytes nor endothelial cells.Adjacent to these capillaries normal functionlcss capillaries may also lose there intramural pericytes and endothelial cells and may he potential sites for saccular aneurysm,Adjaecnt to the distended and tortuous vessels are seen which might have developed to produce collateral circulation. In the beginning their walls are thin but later on get occluded by hyaline material. The haemorrhages are mostly confined to outer plexiform layer and Henle's fibre layer and exudates are formed by polymerization of the unsaturated fats. They are chemically CEROID-wax like material and are regarded as breakdown products of degenerated neuronal tissue. The soft exudates are also seen and result from capillary infarction.


ETDRS classification of Diabetic Retinopathy
Nonproliferative
Proliferative
A. Mild NPDR
B. Moderate NPDR
C. Severe NPDR
D. Very severe NPDR
At least one Microaneurysm
Cotton wool spots & IRMA definitely present
Haemorrhages and microaneurysms in all four quadrants
Any 2 or more of C
Venous beading in two or more quadrants
IRMA in at least one quadrant
E.Early PDR
F. High risk PDR
Neovascularisation not meeting criteria in F
NVD > 1/3-1/2 disc area
NVD and vitreous or preretinal haemorrhage
NVE > ½ disc area and vitreous or preretinal haemorrhage

ETDRS classification [1991]

Diabetic retinopathy is broadly classified as NPDR & PDR. Diabetic macular edema can occur in NPDR as well as PDR.

Mild NPDR- is marked by atleast one retinal microaneurysm, but hemorrhages or microaneurysm or both are less than those in ETDRS standard photograph no. 2A. No other retinal lesions or abnormalities associated with diabetes is present. Those patients with mild NPDR have a 5% risk of progressing to PDR within 1 year and a 15% risk of progression to high risk PDR within 5 years

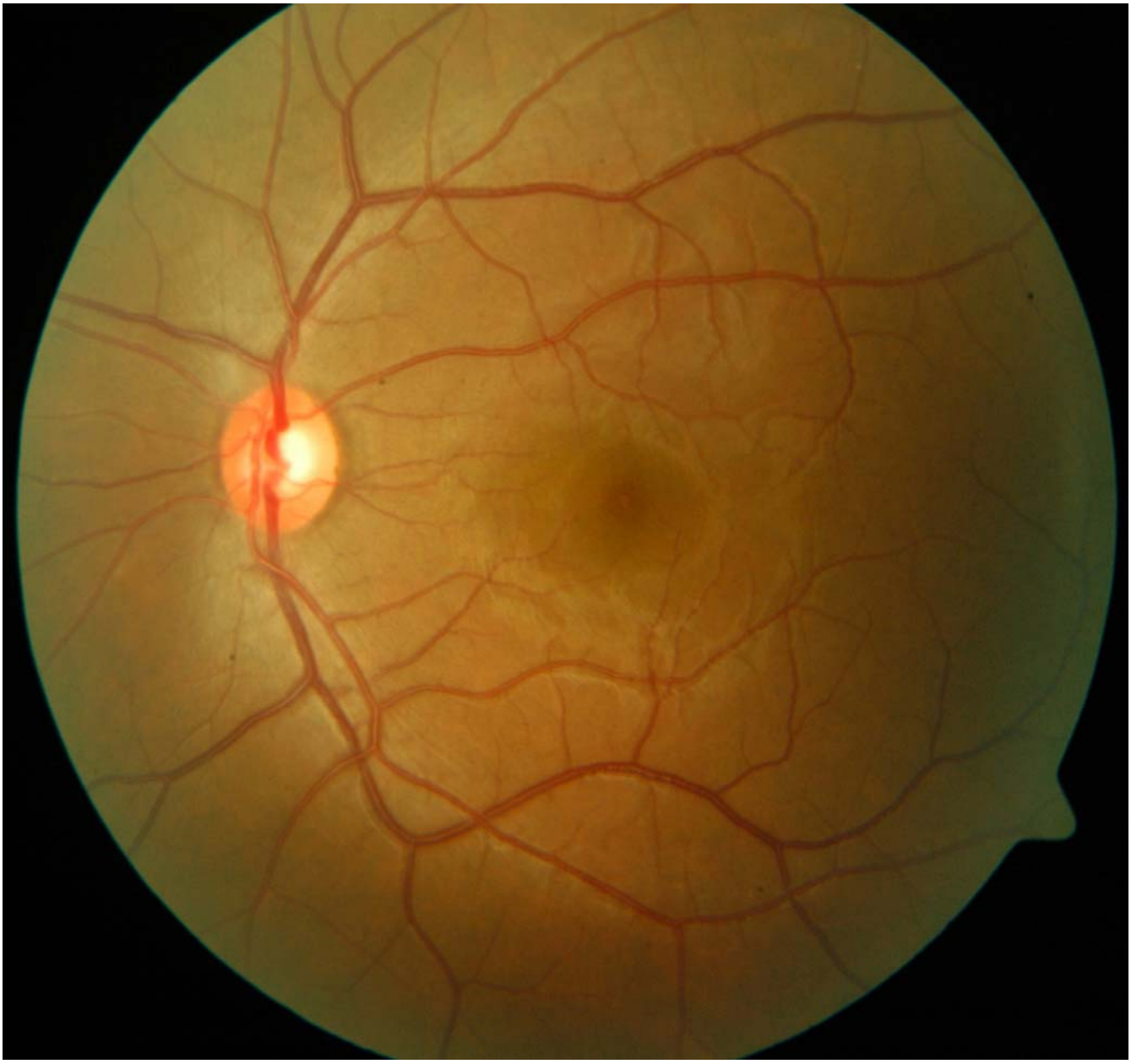
Moderate NPDR- is characterized by hemorrhage or microaneurysm greater than those pictures in ETDRS standard photograph no 2A. cotton wool spots, venous beeding, and IRMAs are definitely present to mild degree. The risk of progression to PDR within 1 year is 12-27% and the risk of progression to high risk PDR within 5 years is 33%.

Severe NPDR- based on the severity of hemorrhage or microaneurysm, IRMAs, and venous beeding is characterized by any one of the following lesions: H/Ma greater than standard photograph no 2A in 4 quadrants OR venous beeding in 2 or more quadrants OR IRMAs greater than standard photograph no 8A in atleast 1 quadrant. Clinically severe NPDR is diagnosed by applying the 4-2-1 rule. Eyes with severe NPDR have a 52% risk of developing PDR within 1 year and 60% risk of developing high risk PDR within 5 years

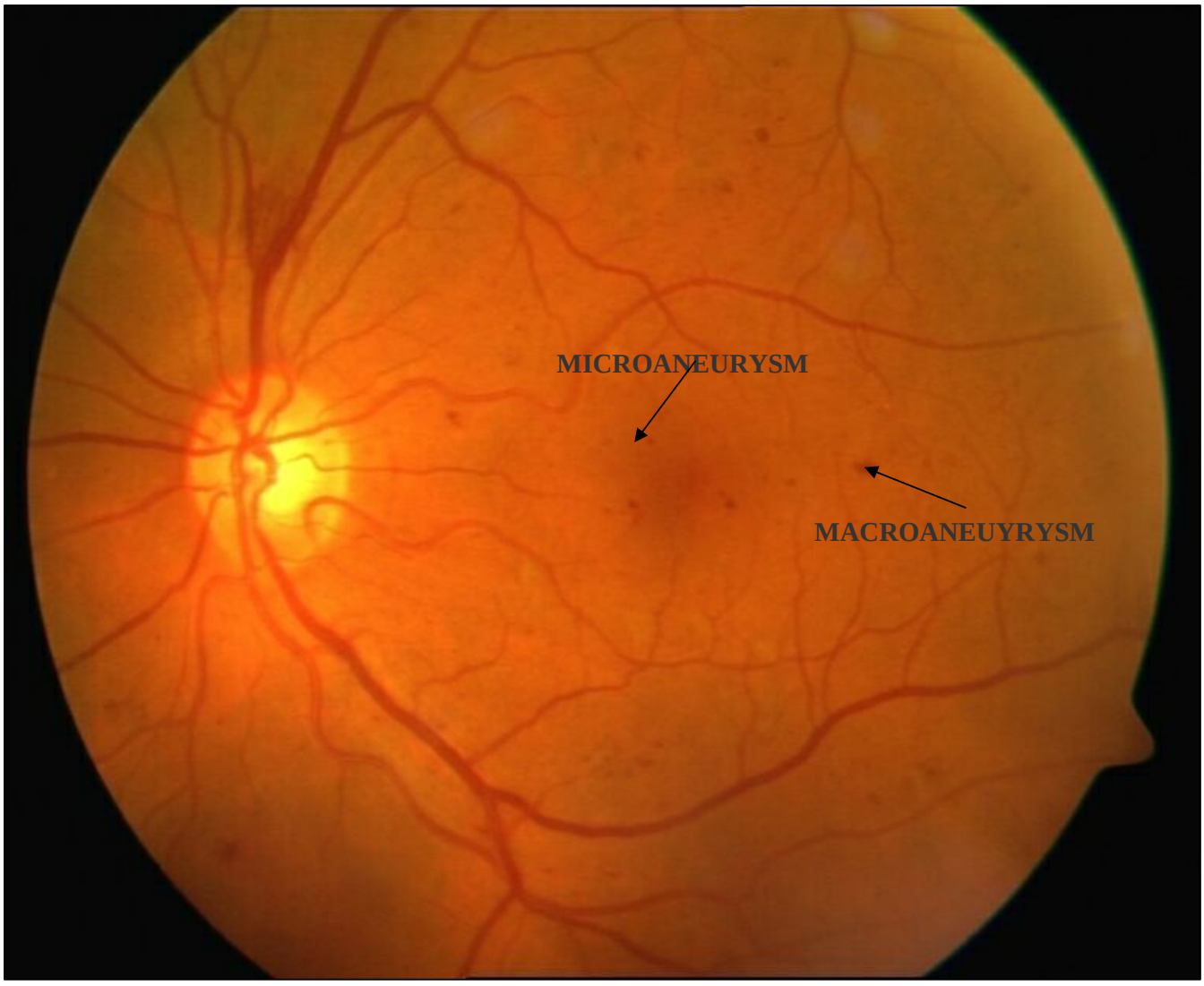
Very severe NPDR- have 2 or more lesions of severe NPDR but no frank neovascularisation. There is 75% risk of developing PDR within 1 year.

PDR- Diabetic retinopathy marked by new vessel growth on optic disc (NVD) or elsewhere (NVE) on retina or by fibrous tissue proliferation is designated PDR. Eyes with early PDR have a 75% risk of developing high risk PDR within 5 year period.

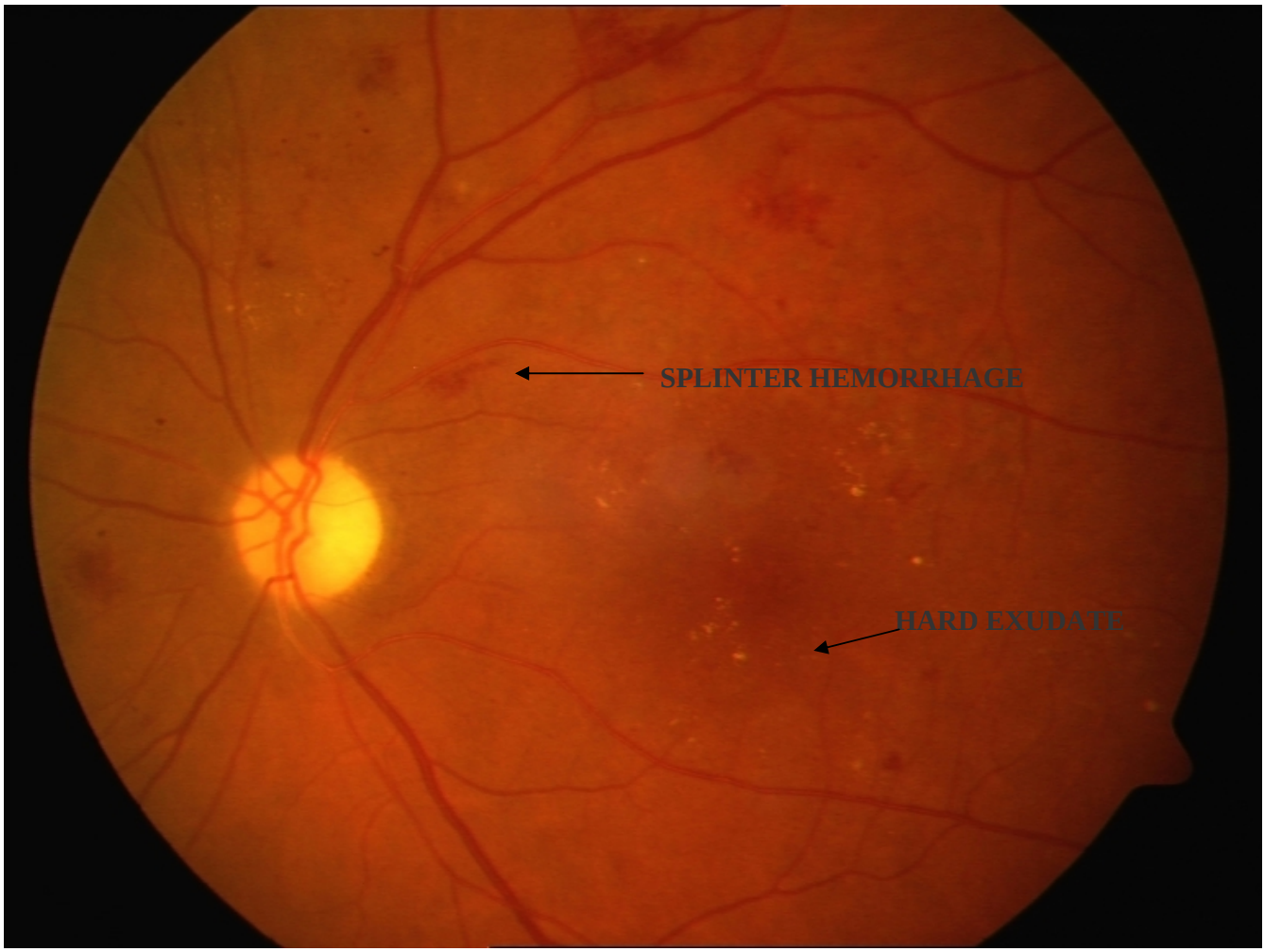
NO DIABETIC RETINOPATHY



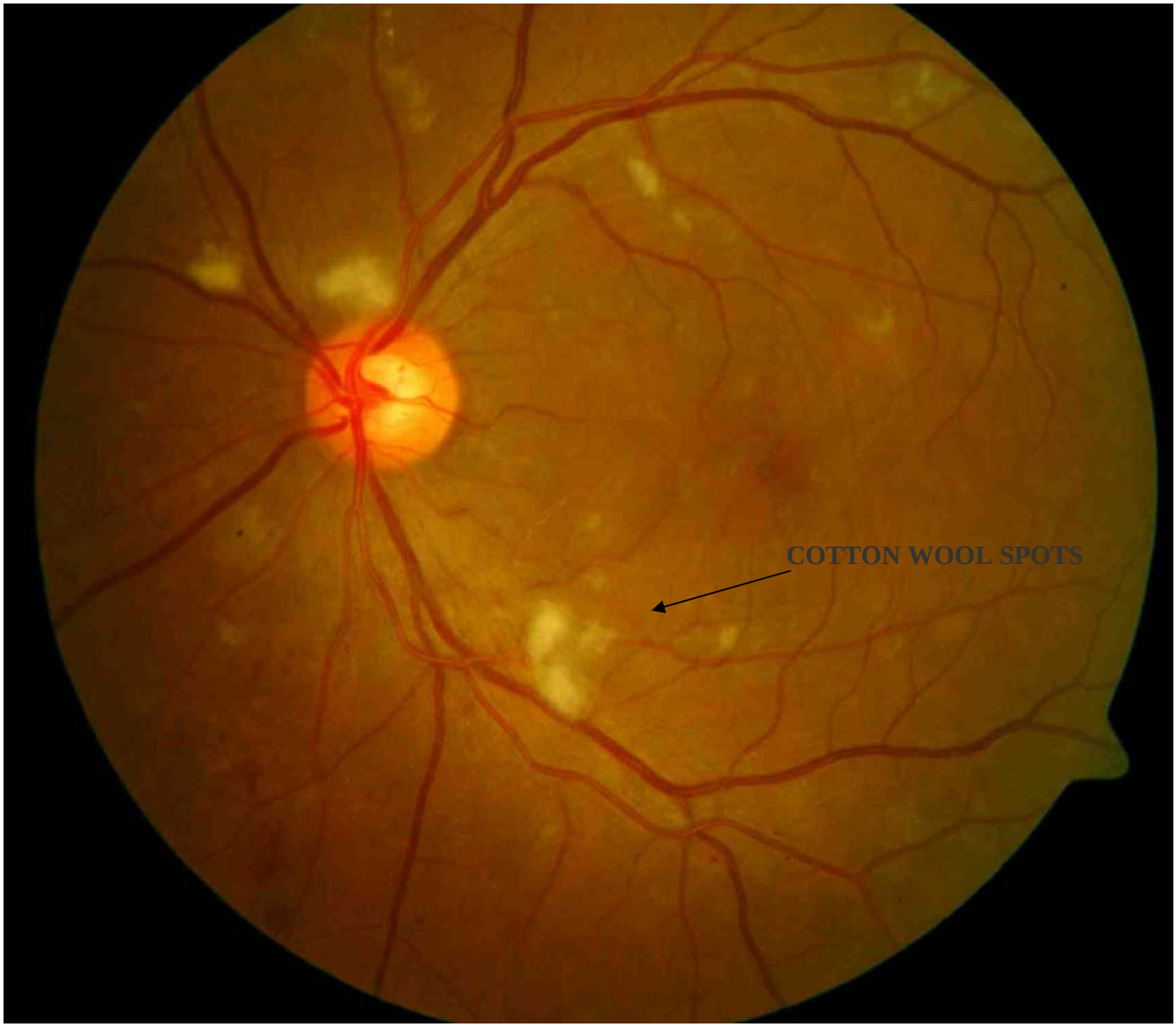
MILD DIABETIC RETINOPATHY



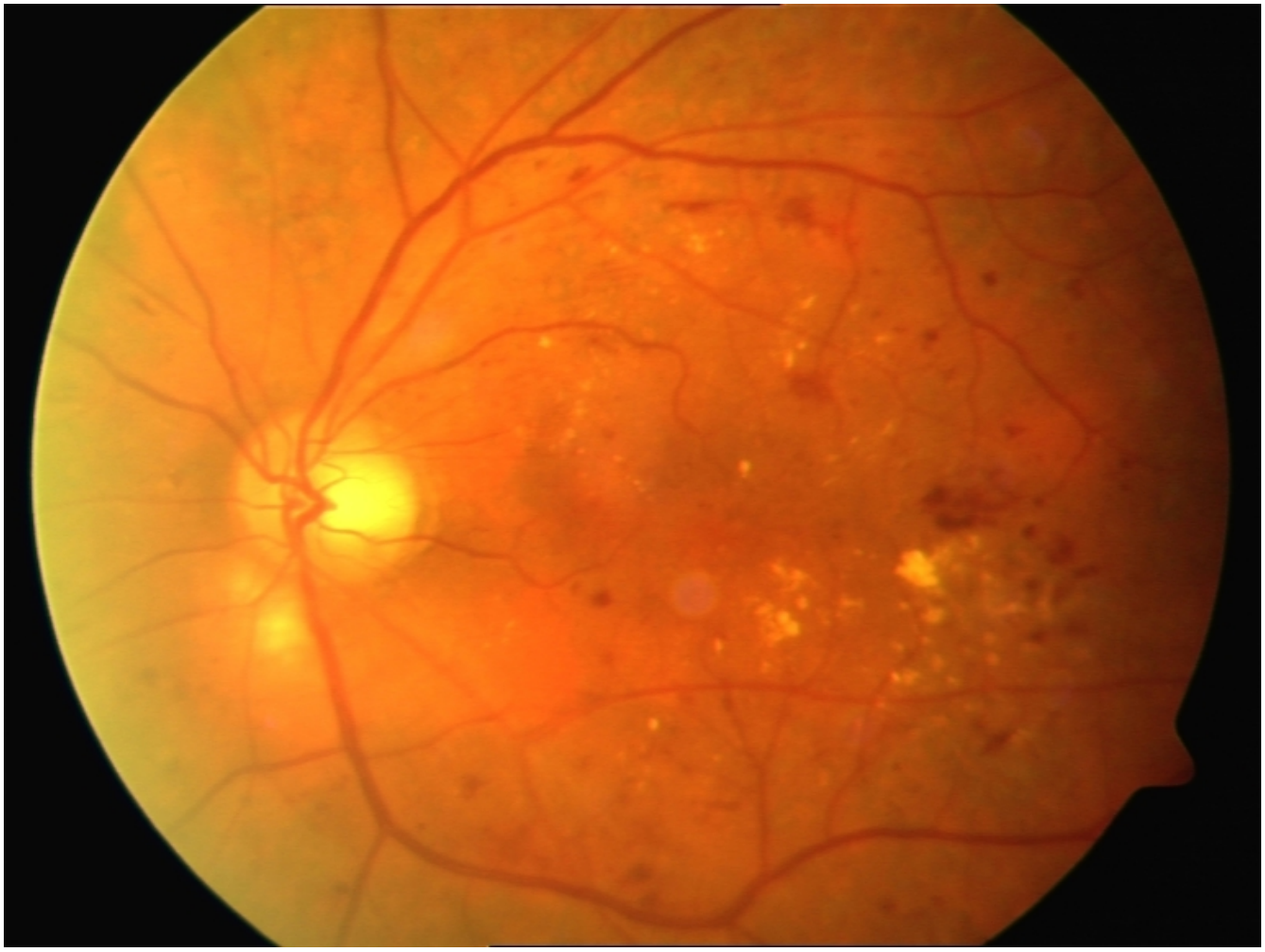
MILD DIABETIC RETINOPATHY



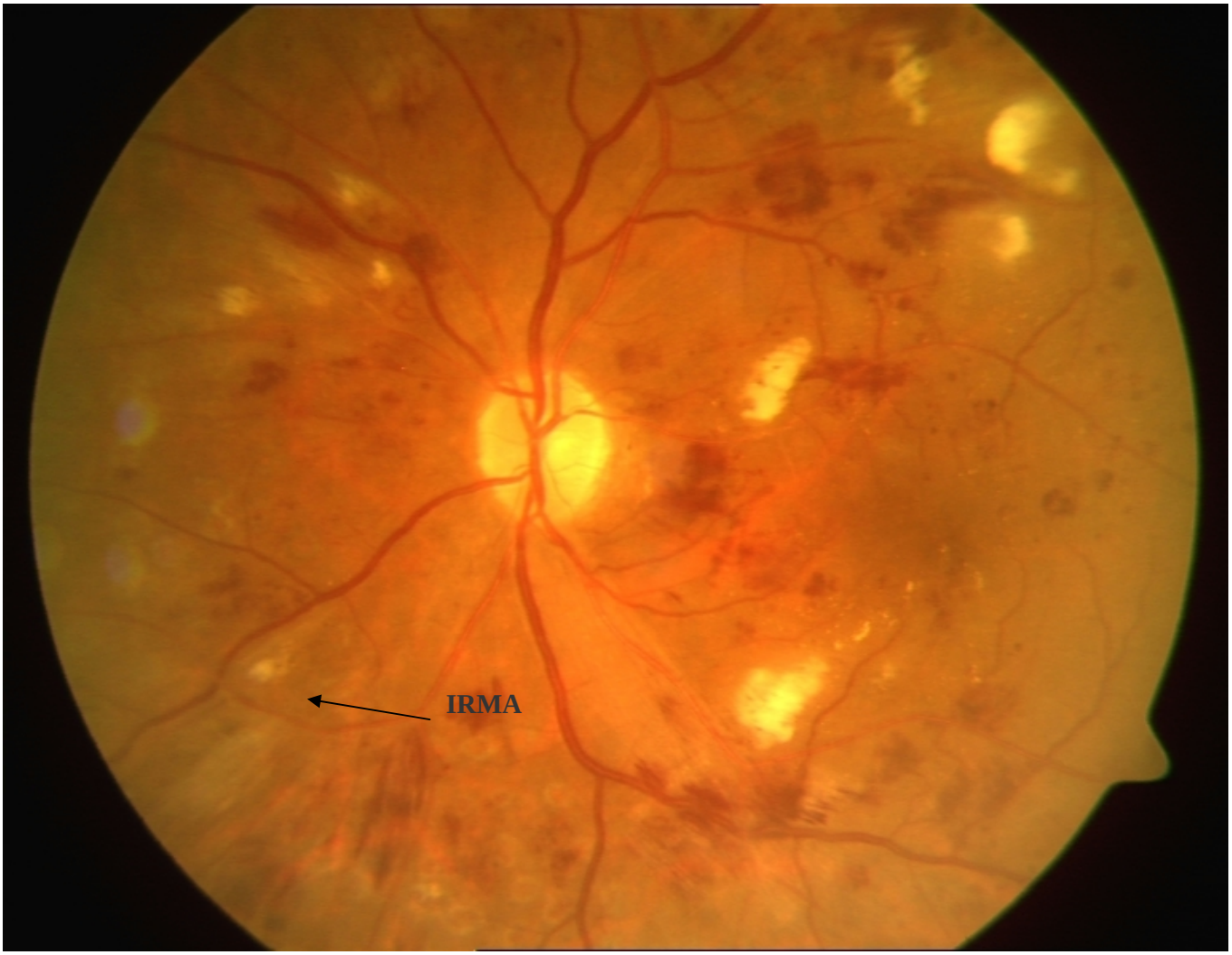
MODERATE DIABETIC RETINOPATHY



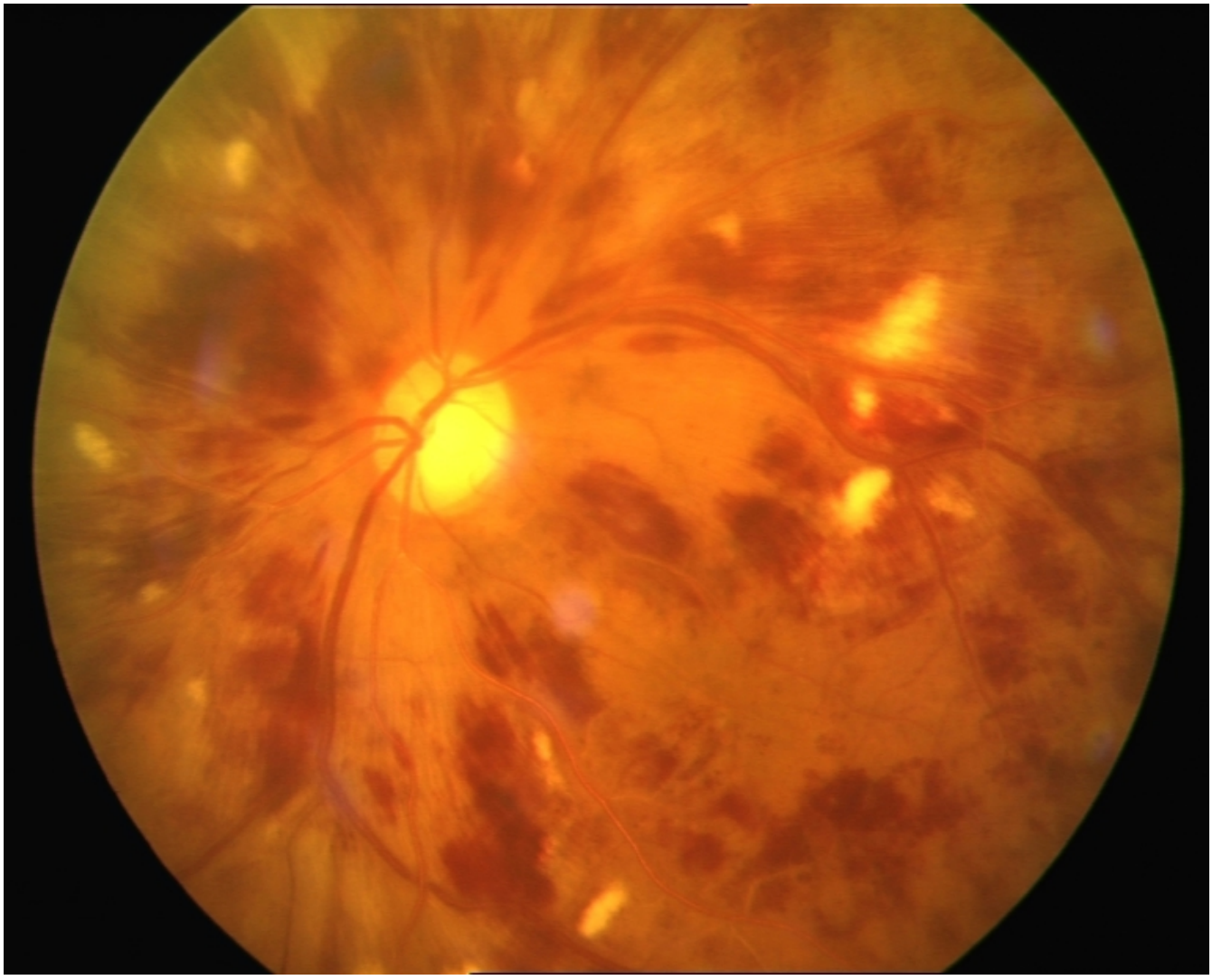
MODERATE DIABETIC RETINOPATHY



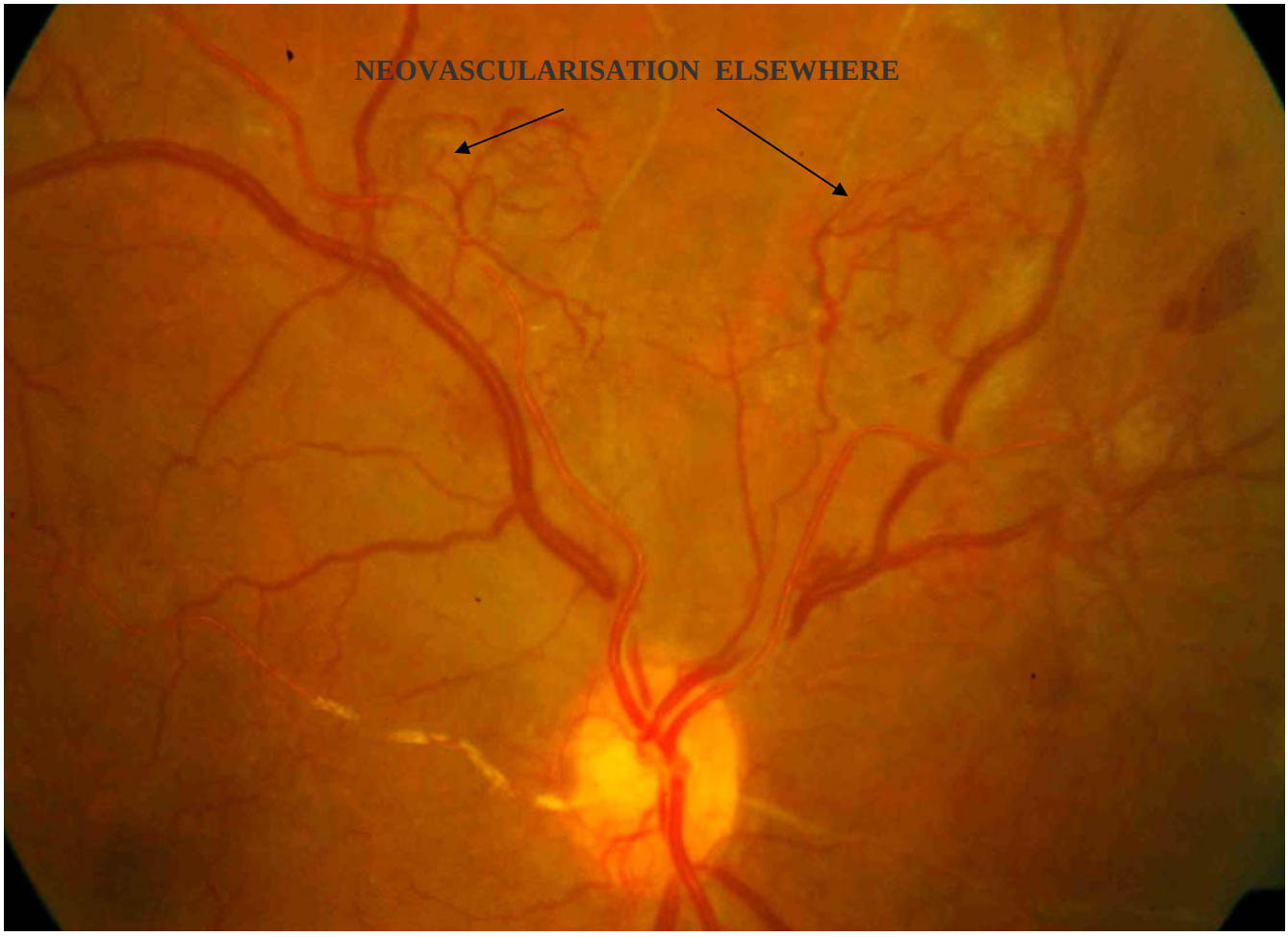
SEVERE DIABETIC RETINOPATHY



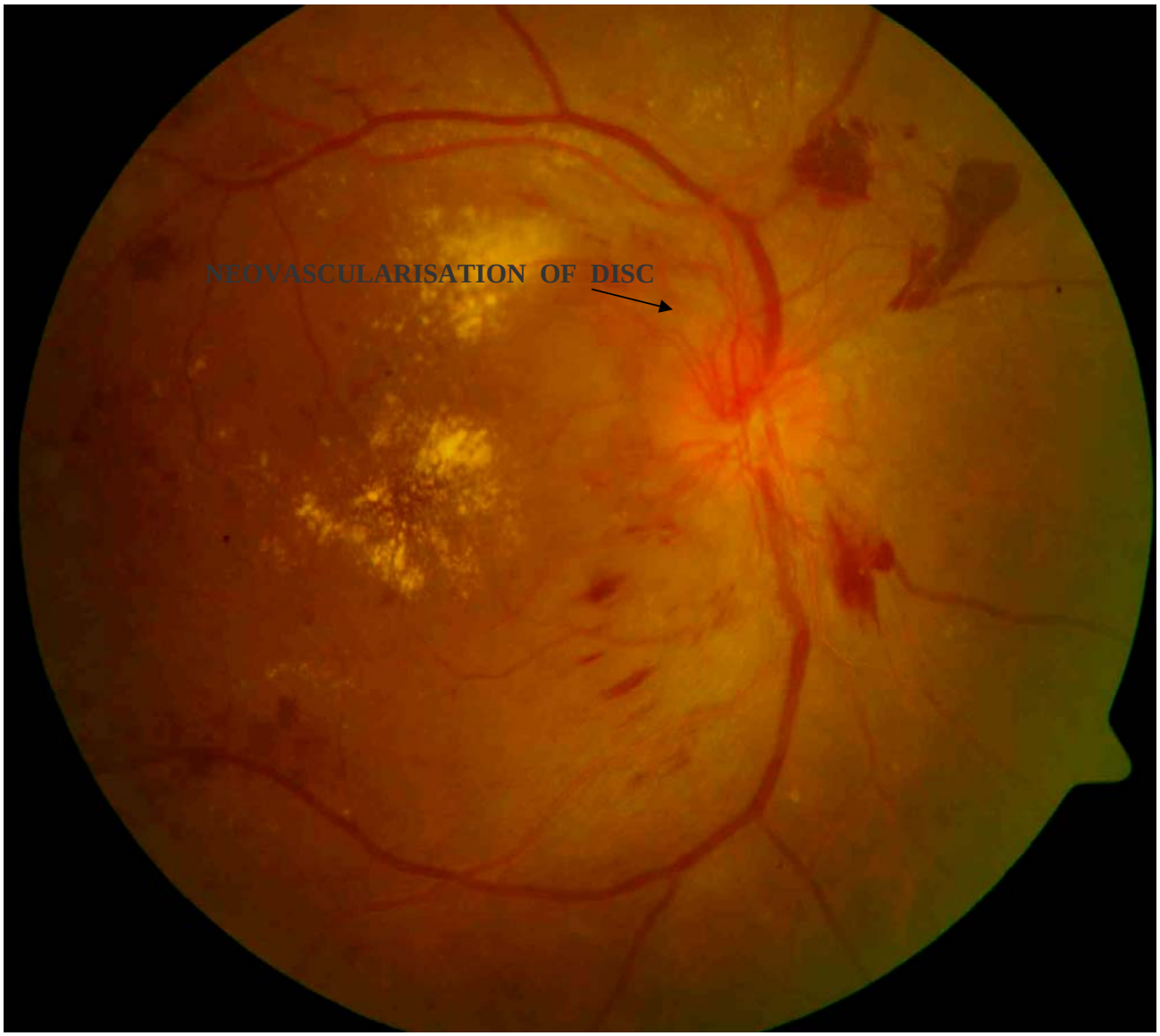
SEVERE DIABETIC RETINOPATHY



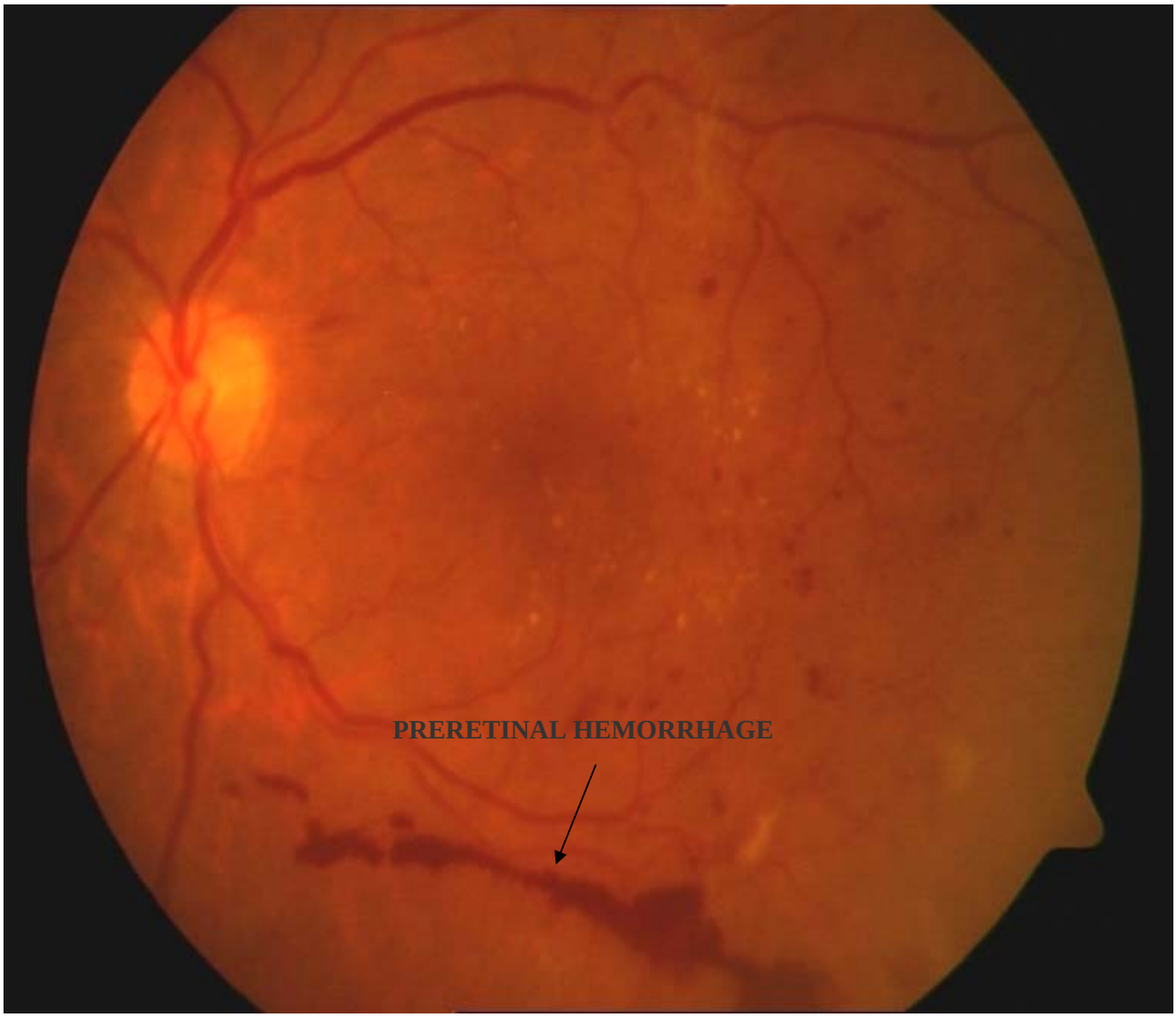
PROLIFERATIVE DIABETIC RETINOPATHY



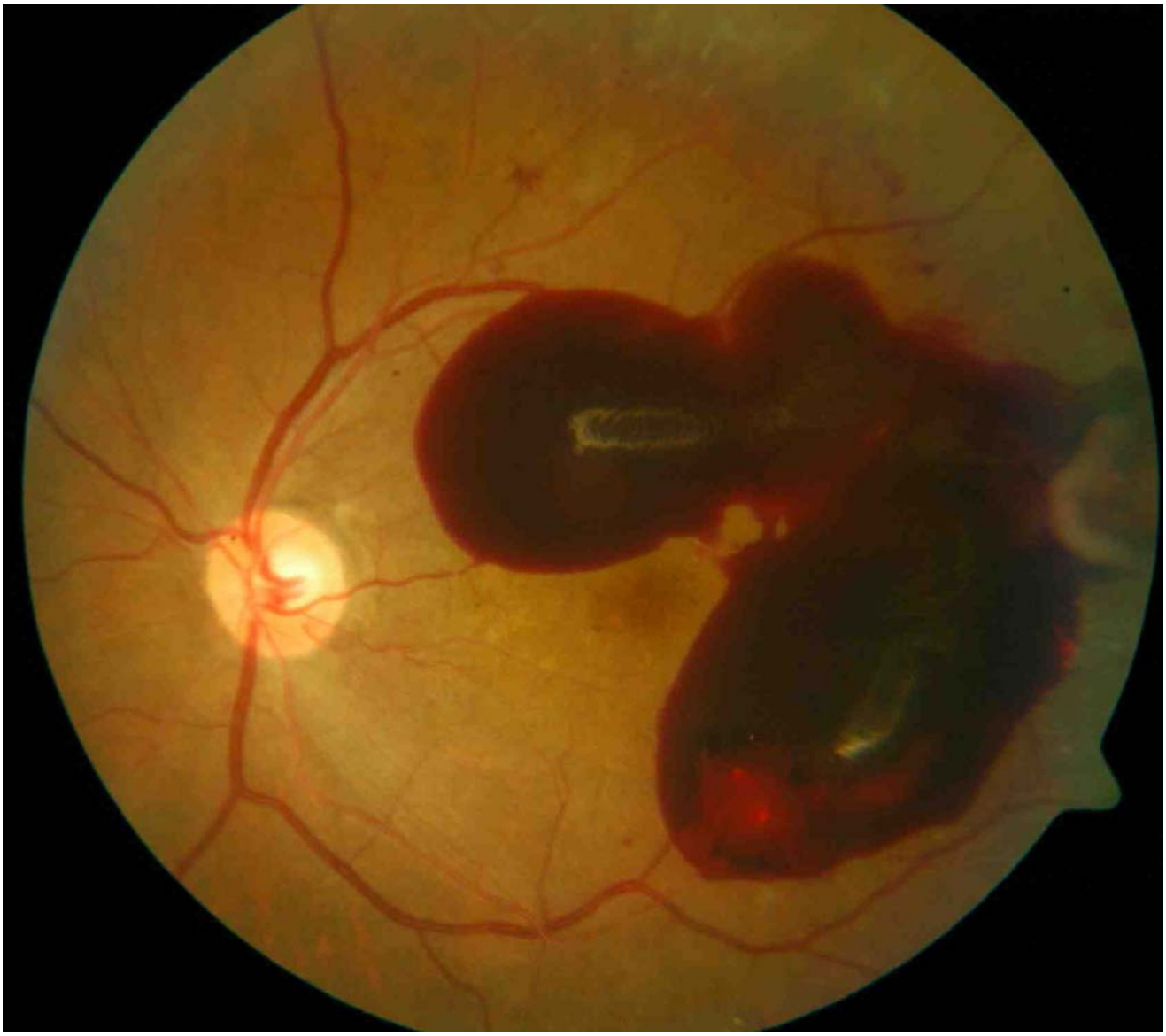
PROLIFERATIVE DIABETIC RETINOPATHY



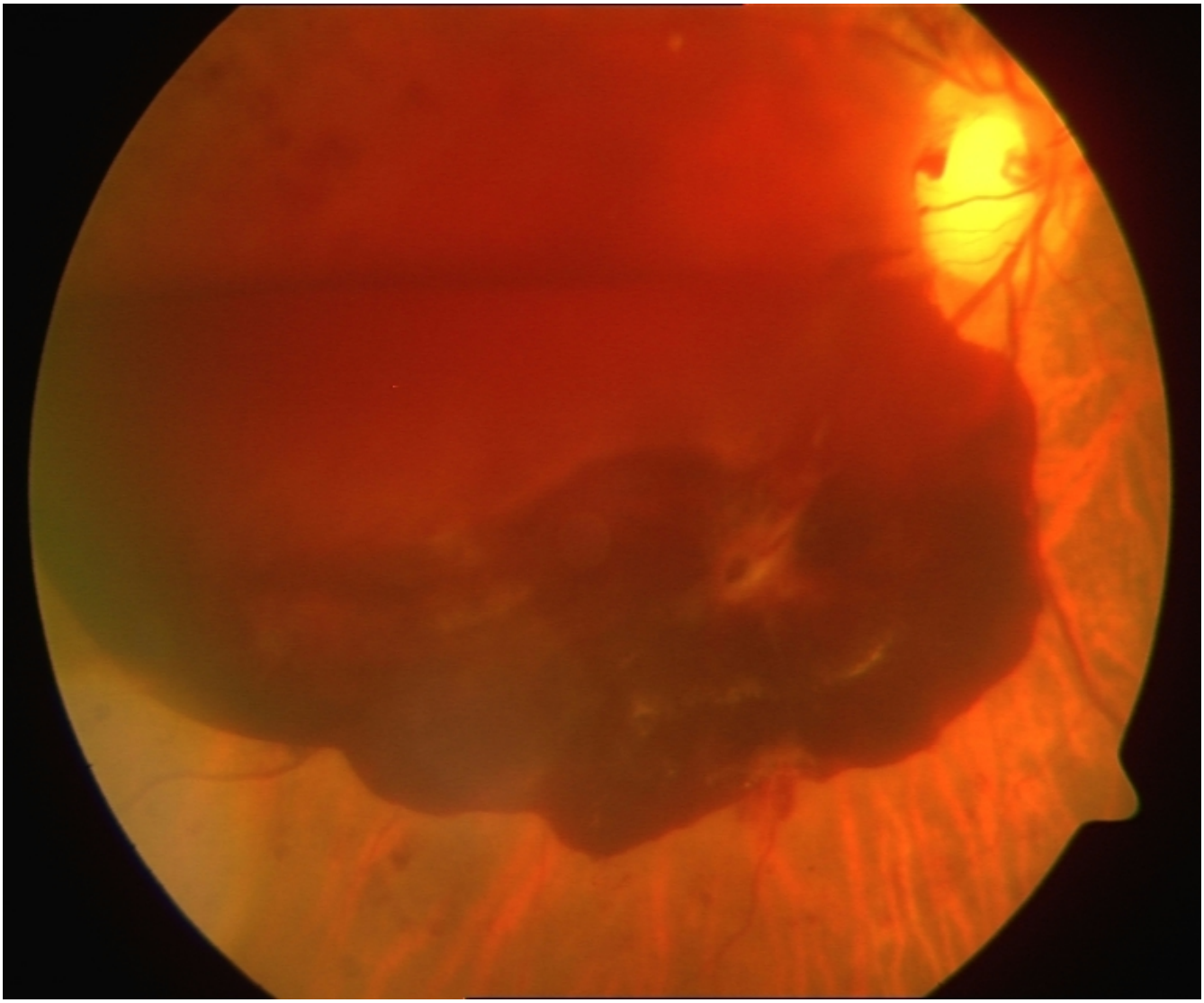
PRERETINAL HEMORRHAGE



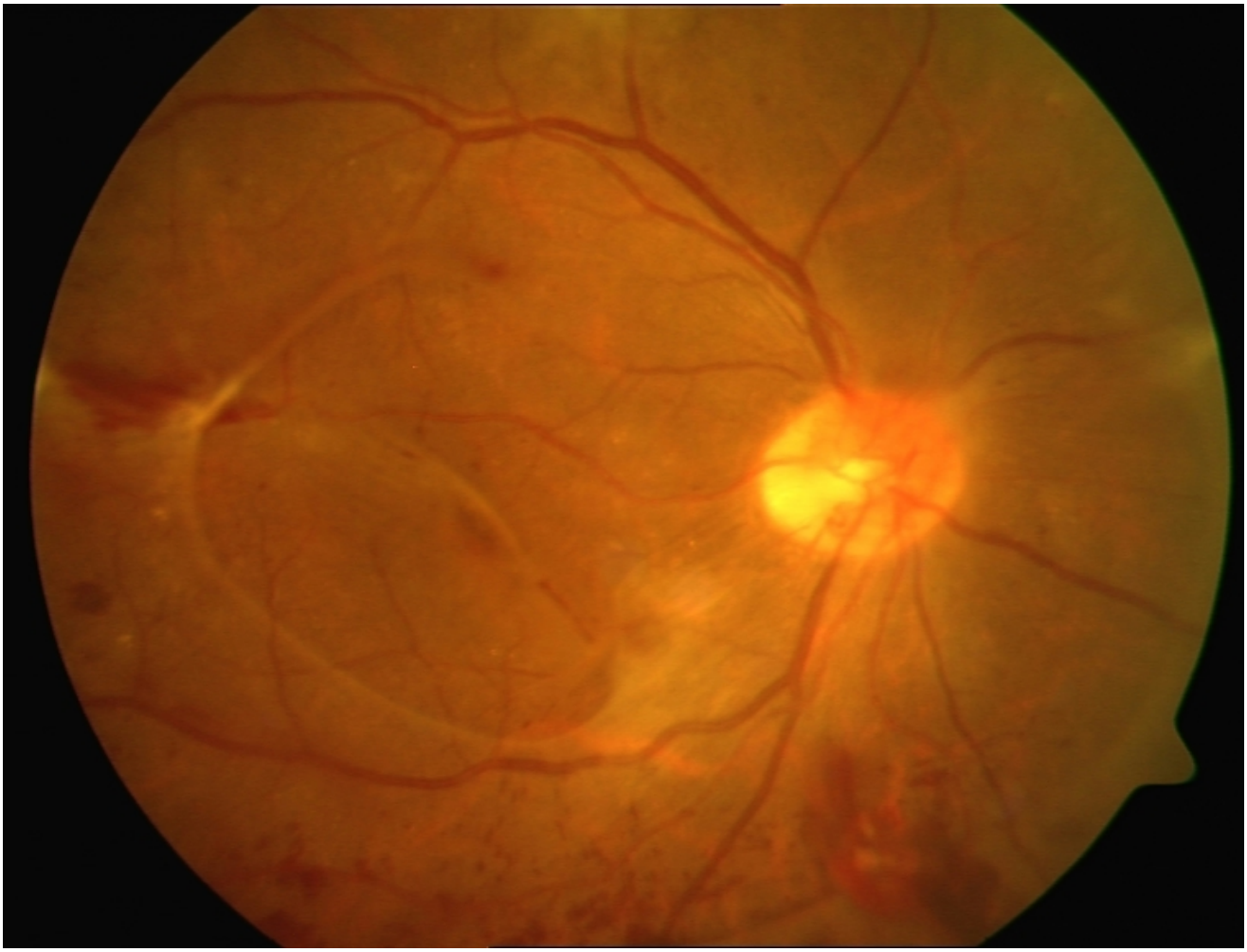
PRERETINAL HEMORRHAGE



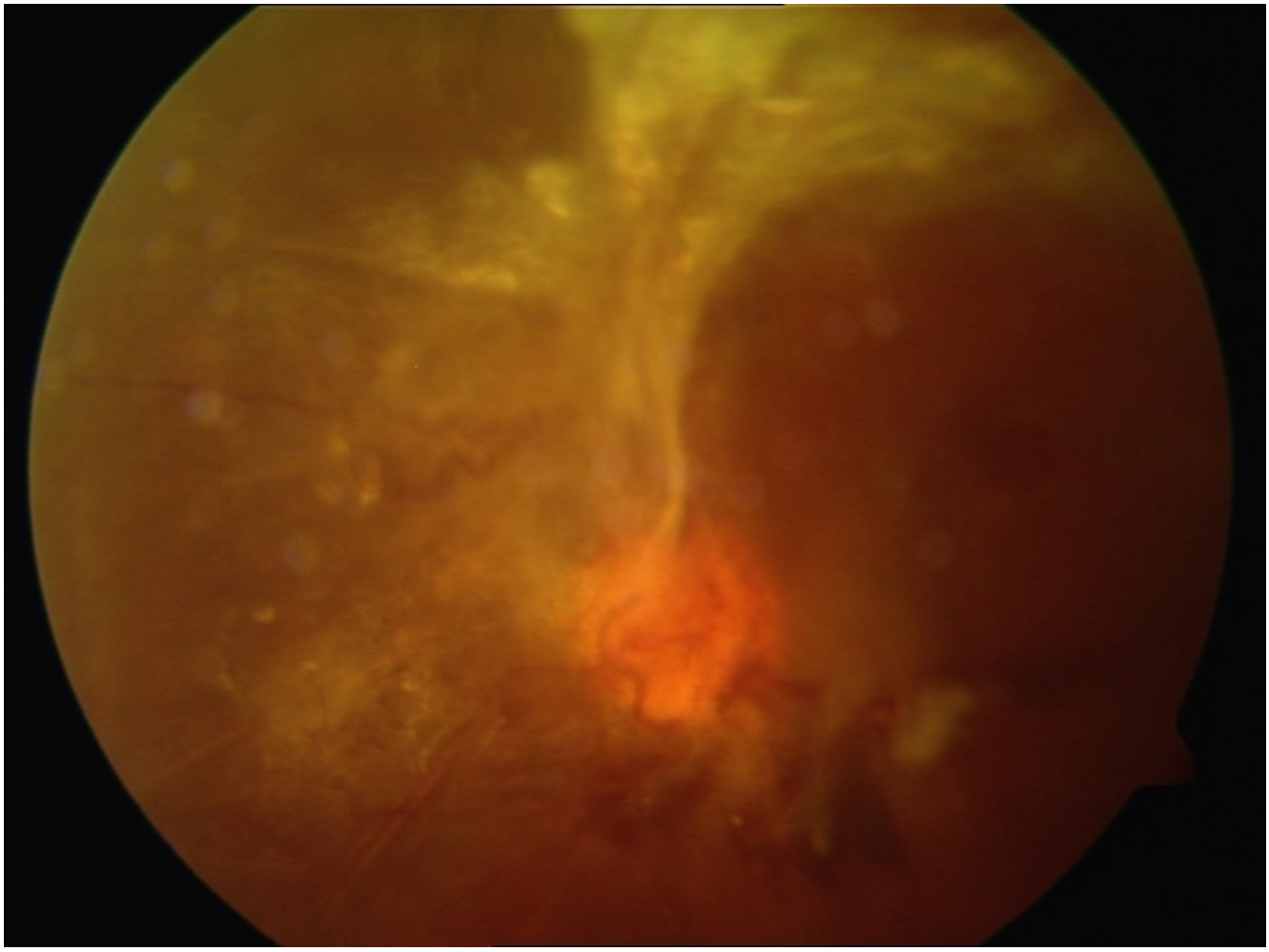
VITREOUS HEMORRHAGE



TRACTIONAL
RETINAL DETACHMENT



TRACTIONAL RETINAL DETACHMENT



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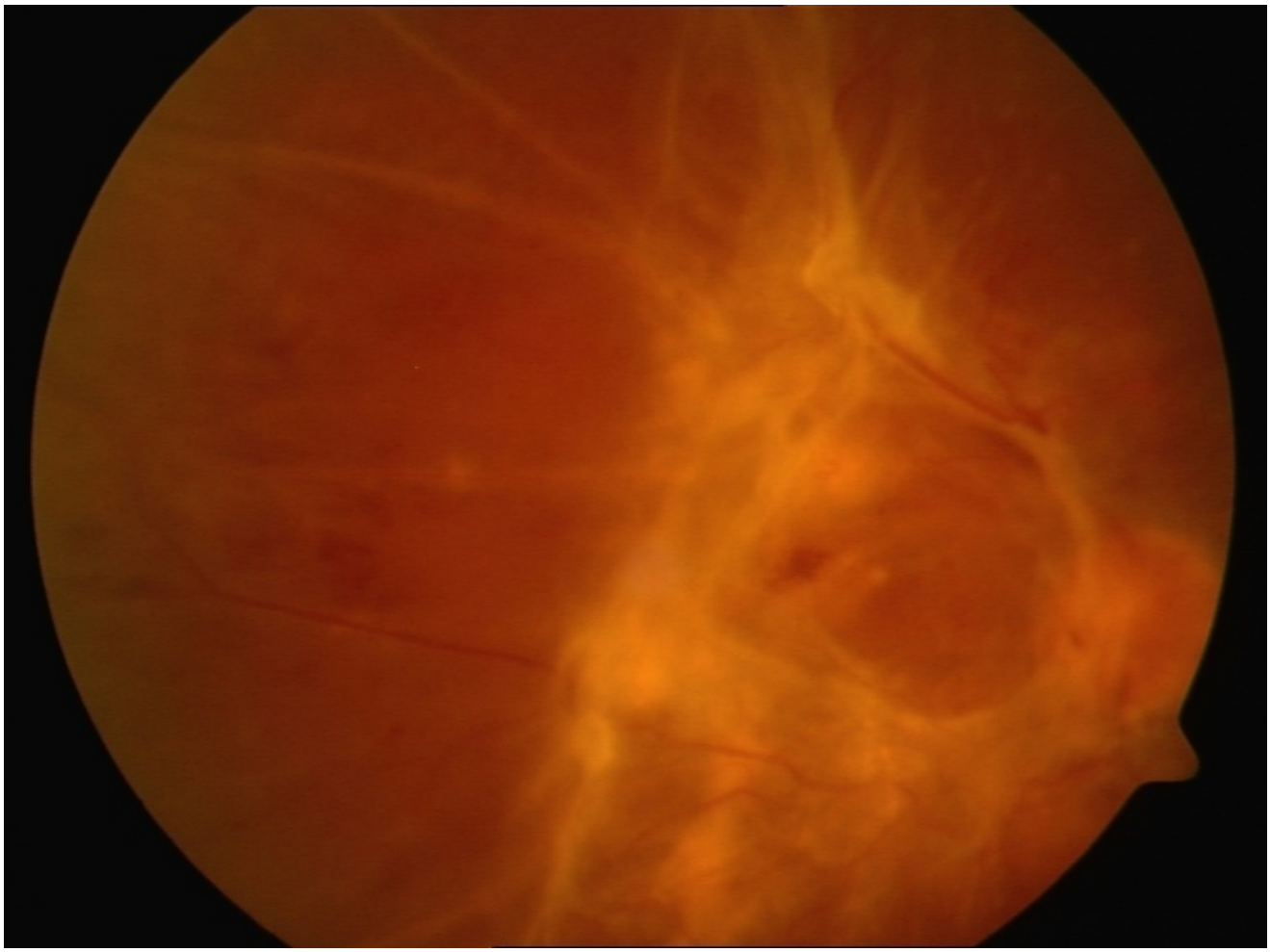


ETDRS also defined the various lesions seen in DR. the various lesions seen are

DEFINITIONS

Microaneurysms (MA)–

A red spot that is less than 1/12 the diameter of an average optic disc, or 125μm in its longest dimension (approximately the width of an average major vein at the disc margin) and that has sharp margins in considered to be a microaneurysm. Any red spot equal to or greater than 125μm in its longest dimension is considered to be a hemorrhage unless features such as round shape, smooth margins, and a central light reflex suggest that it is probably a microaneurysm.

Hemorrhages (H) and/ or microaneurysms (MA)-

All punctate, blot, or linear hemorrhages and all microaneurysms (whether the color of venous blood or paler, and with or without a recognizable wall) are included. Microaneurysms that appear as white dots with no blood visible in a central lumen are graded as hard exudates. Hemorrhages that are clearly preretinal are excluded. The grading is based on the area of retina covered by hemorrhages and/or microaneurysms, using standard photographs 1,2A and 2B for comparison.

Hard exudates –

Hard exudates are small white or yellowish-white deposits with sharp margins. Often they have a slightly waxy or glistering appearance. They are usually located in the outer layers of the retina, but may be more superficial, particularly when retinal thickening (edema) is present. Hard exudates may be arranged as individual dots, as confluent patches, or in partial or complete rings surrounding prominent microaneurysms or zones of retinal edema. The grading of hard exudates is based on the area of retina involved, using standard photographs 3,4 and 5 for comparison.

Soft exudates –

Soft exudates are localized superficial swellings in the nerve fiber layer. They are round or oval in shape, white, pale yellow-white, or grayish-white in color, and have ill-defined (feathery) edges, frequently with striations parallel to the nerve fibers. The grading is based on the area of retina involved, using standard photographs 8A and 5.

Intraretinal microvascular abnormalities (IRMA)-

Tortuous Intraretinal vascular segments, varying in caliber from barely visible to 31μm (approximately one fourth the width of a major vein at the disc margin) or occasionally larger, are the abnormalities considered in this category. Punctate microaneurysms in the retina and new vessels located on the surface of the retina are excluded. The grading is based on the area of the retina covered by IRMA, using standard photographs 8A and 8B.

Venous abnormalities-

In the ETDRS, three abnormalities that were combined in the DRS grading protocol are assessed separately: (a) venous beading, (b) venous narrowing, and (c) venous loops and/or reduplication. Venous sheathing and perivenous exudates are graded as in the DRS. Diffuse increase in venous caliber is not graded, because it is considered too difficult to evaluate consistently. Abnormalities within one half disc diameter (DD) of the disc margin are ignored.

Venous beading-

Localized increases in venous caliber, which sometimes resemble a string of beads and are typical of diabetic retinopathy, are the abnormalities assessed.

The grade is based on the total length of vein involved and the severity of beading, using standard photographs 6A and 6B for comparison.

Venous narrowing-

Localized narrowing of venous caliber is the abnormality considered. The total length of all narrowed segments within the field being graded is estimated and compared with the width of an average major vein at the disc margin (considered to be 125μm) and the diameter of an average disc.

Venous loops and/or reduplication-

A venous loop is an abrupt, curving deviation of a vein from its normal path. Reduplication of a vein is the dilation of a pre-existing channel or the proliferation of a new channel of similar caliber adjacent to the original vein. The grading is based on the caliber of the vein involved.

Venous sheathing-

White lines along one or both sides of the venous blood column (sheathing) and/or complete opacification of the venous wall (white threads) are the abnormalities graded. The total length of vein having either appearance is assessed, as with venous narrowing.

Perivenous exudates-

Hard exudates occurring immediately adjacent to one or both sides of retinal veins, simulating venous sheathing, are classified as perivenous exudates and graded separately. The total length of vein involved is assessed.

Arteriolar abnormalities-

Abnormalities within ½ DD of the disc margin are ignored

Arteriolar narrowing-

Localized irregularities in arteriolar caliber are the abnormalities graded. Because it is considered too difficult to grade consistently, generalized narrowing is not evaluated, except to indicate narrowing so extensive that the arterioles and white threads are excluded when grading arteriolar narrowing. The grading is based on the length of arteriolar segments involved, using standard photographs 11 and 7.

Arteriolar sheathing-

Arteriolar walls that are partially opaque (a ribbon of red blood can still be seen with white lines on one or both sides of it) or completely opaque (no visible red blood column), are the abnormalities graded. The total length of arteriole that is either partially or fully opaque is assessed, using as cut points on the grading scale 125μm and standard photographs 5 and 7.

New vessels -

New vessels that are clearly on the surface of the retina (that is, not within the retina) or further forward in the vitreous cavity are considered to be new vessels elsewhere (NVE), except for those on the disc or within 1 DD of its margin (or in the vitreous anterior to this area), which are designated new vessels of the disc (NVD). However, if new vessels located mostly elsewhere extend into the area between ½ and 1 DD from the disc margin, and no other new vessels are present closer to or on the disc, all new vessels are included in the NVE category. These same criteria are used to distinguish between fibrous proliferations elsewhere (FPE) and fibrous proliferations of the disc (FPD). The grading is based on the area of retina covered by the new vessels, using as cut points on the grading scale ½ disc area (DA) and the NVE in standard photograph 7.

Preretinal hemorrhage-

Both boat-shaped hemorrhages with a fluid level and round, oval, or linear patches of the hemorrhage just anterior to the retina or under its internal limiting membrane are included. Hemorrhage on the surface of detached retina is also considered to be preretinal hemorrhage. The grading is based on the area

of retina covered by hemorrhage, using standard photographs 9 and 13 and the area of one half of the field for comparison.

Vitreous hemorrhage-

Hemorrhage further forward in the vitreous cavity than pre retinal hemorrhage(PRH), including hemorrhage on or within fibrovascular proliferations, is considered to be vitreous hemorrhage (VH) .

The United Kingdom Prospective Diabetes study (UKPDS) was a landmark trial in NIDDM. It was a multicentric, randomised control trial. Both eyes of 2964 patients were studied. It concluded that increased blood pressure and increase fasting plasma glucose was associated with increased severity of retinopathy. Other conclusions derived were that retinopathy was more prevalent in men than women, body mass index (BMI) was inversely related to severity of retinopathy in women but not in men. High density lipoproteins (HDL) which has a protective role in atherosclerotic diseases was found to have inverse relationship with severity of retinopathy in men, i.e. higher HDL levels were associated with increased severity of retinopathy in men. But this was not so in women .

The Wisconsin Epidemiologic study of Diabetic Retinopathy which include 634 patient with IDDM also concluded that progression of retinopathy is more in males, in those having higher glycosylated hemoglobin and higher diastolic blood pressure at baseline .

BIO-CHEMICAL ASPECTS IN DIABETIC RETINOPATHY

Diabetes occurs essentially in two forms: type 1, *formerly known as juvenile-onset diabetes (or type I); and type 2, which was once called mature-onset diabetes (or type II).* Although the mechanisms for each vary, both forms involve an inability of glucose to enter certain classes of cells in the body that are dependent upon insulin-activated, transport protein systems.

TYPE 1 DIABETES : Type 1 diabetes was formerly called “juvenile diabetes” since it typically becomes manifest by age 20. However, it is now known that this form can occur after that age. Type 1 was also known as “insulin dependent diabetes” since its patients require periodic insulin injections. Again ,however patients with type 2 diabetes sometimes also require insulin injections. The immediate cause of type 1 is usually an autoimmune destruction of the b-cells of the pancreas that synthesize insulin. In addition to its role in glucose uptake , insulin signals the initiation of many other cell metabolic functions : amino acid uptake , glycolysis, formation of glycogen , and lipid synthesis as well as the

synthesis of proteins , DNA, and RNA. One can say that insulin is vital hormone since it communicates the continuation of cell nutrition and growth overall. However, the uptake of glucose remains as one of its most important functions.

The destruction of the b-cells of the pancreas , as mentioned above , appears to be an autoimmune phenomenon. There is a strong genetic component to the appearance of this form of diabetes, which is associated with the chromosome 6 genes for the *human leukocyte antigens* (HLA). Wildman and Medeiros(2000), describe these proteins , made by their respective genes, as critical for distinguishing between host and foreign cells. Because of the loss of insulin , high levels of glucose remain in the circulating blood long after the consumption of a meal. For this reason , type 1 diabetes has also been known as insulin dependent diabetes mellitus (IDDM).

It is important to understand that those cells that depend on insulin (those that have GLUT-4 transport proteins) become starved for nourishment while other cells , not dependent on insulin , become exposed to higher than normal cytoplasmic levels of glucose . This is to say that some cells have decreased nutrition while other cells are actually exposed to toxic levels of glucose. Cells that are particularly insulin dependent are muscle cells (cardiac, skeletal , and smooth) as well as adipose (fat) cells (McGilvery, Goldstein, 1983) and *cells of blood vessel walls* (Koschinsky, 1988). Among the cells

which are not insulin dependent are liver cells , nerve cells, red blood cells , bone cells, and *lens fiber cells* of the eye. This is why the enzyme aldose reductase is activated within lens fiber cells of the eye. This is why the enzyme aldose reductase is activated within lens fiber cells in the diabetic state.

In diabetes, particularly type 1, the insulin dependent cells alter their metabolism in pathological (i.e., abnormal) ways in order to compensate for their lack of glucose . In muscle cells, for example , it is common in the diabetic state to accelerate the breakdown of aminoacids in order to obtain acetyl CoA as a precursor for ATP production. This occurs at the expense of muscle proteins in the body. In muscle cells, for example, it is common in the diabetic state to accelerate the breakdown of aminoacids in order to release fatty acids back into the bloodstream. These fatty acids are taken up by the liver to produce acetyl CoA for the same purpose of synthesizing ATP. However, in this case , not only are the stores of lipid reduced , but there is also a production of toxic intermediates from excessive fatty acid breakdown. These toxic intermediates are known as *ketone bodies*. Most ketone bodies (acetoacetate and B-Hydroxybutyrate) are sufficiently acidic to lower blood pH to dangerously low levels. This could occur to the point at which the patient might become comatose and, if untreated, could expire due to complications such as severe dehydration , respiratory distress, cerebral edema, and thromboembolism. Of

course, this represents an extreme of untreated type 1 diabetes or, in some cases , where insulin therapy management is very difficult.

High circulating levels of glucose can also bind to proteins both extracellularly and intracellularly (in those cells that do not have GLUT-4 transport proteins). The binding of glucose to proteins is known as glycation. Glycation is a slow reaction that proceeds through many steps. It is important to note that the reaction is permanent, meaning that when glucose levels are lowered the binding of glucose to the protein does not dissociate. Rather the reaction continues and produces more complex forms that result in the denaturation of the protein in what is known as the *Maillard reaction* (Berman ,1991). Finally, it should be noted that glucose in high concentrations has been proposed to cause DNA damage (Morita et al, 1985) . However,Schleicher et al (2001) , have indicated that only $1x\ 10^{-5}$% of the guanine nucleotides of DNA would be expected to react with a glucose derivative in the diabetic state. This is a negligible amount.

TYPE 2 DIABETES: In type 2 diabetes formerly known as noninsulin dependent diabetes mellitus(NIDDM), there is *either* an insufficient number of functional insulin receptors on the plasma membranes of insulin dependent cells or the receptors, in normal amounts, fail to promote sufficient glucose uptake (Mathews, van Holde , 1990; Martin et al, 1985). The phenomenon of insufficient response to normal amounts of insulin is called *insulin resistance.*

In addition, patients with this disease also exhibit a somewhat decreased levelof secreted nsuln for unknown reasons. This insulin deficiency , however , does not often require insulin therapy. The cause(s) of type 2 diabetes remain vague (Wildman, Medeiros, 2000).

One causative attribute has been the association of this disease with obesity. How this occurs is not certain, but some evidence is available. For example , enlarged adipocytes (fat cells) secrete a protein known as *tumour necrosis factor-alpha* that has been shown to inhibit insulin receptor autophosphorylation.

A characteristic of type 2 diabetes is that the associated hyperglycemia tends to develop more slowly than with type 1 and is of a milder degree. Ketoacidosis , in untreated type 2 diabetics, occurs much less often and then it is usually associated with physiological stress such as an infection. Returning to the problem of insulin resistance , one may point to not only the insulin receptor protein, but also to any of the proteins associated with the cascade from the receptor to the placement of GLUT-4 molecules at the the cell plasma membrane (Pessin, Saltiel,2000). This means that any number of proteins may contribute to the resistance. Numerous data support this to indicate many possible causes of the disease and emphasizes the difficulties of trying to comprehend how this disease can manifest itself. In addition to the effect of fat cells on the insulin receptor, investigations have shown that knocking out the

gene for the *insulin substrate proteins* (insulin receptor substrates) in mice can produce insulin resistance as well as cause a decreased b-cell production of insulin in the pancreas(Kulkarni et al , 1999). The next protein in the cascade is phosphatidylinositol 3-kinase (PI3-K). Although PI3-K activity id necessary for the ultimate transport of GLUT-4 to the plasma membranes of insulin dependent cells (Chez, Corvera,1999) , its activity is not sufficient to carry out the transport. This means that additional mechanisms are involved(Pessin, Saltiel,2000) and, clearly , more work will be necessary to unravel the causes of insulin resistance. In spite of these uncertainties , a controlled diet coupled with exercise is often sufficient to manage type 2 diabetes.

The Diabetic Retina: The retina is vulnerable to diabetes due to deterioration that occurs to its blood vessels in a condition known as *diabetic retinopathy*. This is similar to diabetic blood vessel damage that also occurs to other parts of the body such as the kidneys , brain , and limbs. Essentially , in the retina pericytes are destroyed while the lumen of the vessel becomes blocked due to vessel swelling as the basement membranes thicken (Apple et al, 1988). As vessel pathology develops, haemorrhages and retinal detachment follow. The terminal result of these events is loss of vision in parts or all of the retina. Shedding light on a biochemical mechanism by which this damage occurs has proven to be a Pandora's box. As the box is opened, out pops the familiar enzyme *aldose reductase* and its role of removing excessively toxic amounts of

glucose from within cells such as blood vessel endothelial cells. Again, the problem of the generation of osmotic sorbitol arises. The problem (the presence of large amounts of high osmotic, cell destroying sorbital) and the solution (development of an effective inhibitor for aldose reductase) are seen as logical exercise. However , other previously unknown participants emerge from the Pandora's box: *protein kinase C (PKC); mitogen-activated protein kinase (MAPK); protein glycation; and oxidative stress* (Tomlinson, 2000). The complications to understanding that are generated by these other substances mechanisms are, nonetheless, now seen as more important in the retina compared to the lens osmotic hypothesis. This is so since aldose reductase inhibitors do not seem to have any significant effect on the prevention of blood vessel degeneration in the retina. What roles might these other substances and mechanisms play?

In 1996 , King reported thathigh levels of glucose cause an increase in *diacylglycerol(DAG)*, a phospholipid precursor that is synthesized from glyceraldehydes 3-phosphate and dihydroxyacetone phosphate. The latter two substances are generated in the E-M pathway from glucose. DAG stimulates the activity of protein kinase C (PKC), an enzyme that acts as a part of a hormone cascade system at cell surfaces . PKC, as part of its many physiological functions, increases both blood vessel permeability and the excessive synthesis of blood vessel membranes. One of the features of diabetic blood vessels is their

"leakiness" (permeability) and their thickening with the synthesis of basement membranes. In a more recent publication . Park et al(2000), indicate that PKC causes the induction of the synthesis of the protein *endothelin-1(ET-1)*. This protein is responsible for increased blood vessel permeability as well as its thickening . similar effects may also be made through the activation of *mitogen activated protein (MAP) kinase*, an enzyme that translocates into the nucleus of the cell and affects many different cell functions *via* phosphorylation (Lodish et al ,2000).

Another effect of diabetes that arises from the Pandora's box is the binding of glucose to proteins (glycation). In higher glucose concentrations , this occurs initially by what is known as the "Amadori rearrangement" of an initial Schiff base (aldimine) formation and is a *ketimine*. These protein-carbohydrate conjugates seem to occur in a number of extracellular proteins as well as the intracellular proteins of noninsulin dependent cells (Cohen, 1986). Such early stage complexes are exemplified by the existence of glycated hemoglobin (HbA1c) in the blood. HbA1c can actually be used to assay how well blood glucose control is being maintained in a diabetic (Wiliams, Pickup, 1999). Among those proteins known to be bound by glucose are collagen , crystallins, and enzymes such as NaK-ATPase, as well as hemoglobin.

Unfortunately, the initially formed protein-glucose ketimines may continue to react with time to form somewhat complex, permanent and

generally undefined, *advanced glycation end-products (AGEs)* as reported by Brownlee (1996). Among these AGEs, one has recently been described as an imidazole-crosslinked protein. AGEs produce a variety of effects including : (1) binding to receptors on vascular endothelial cells to produce a blockage in the vessel ; (2) a leakage of the vessel itself; (3) vessel dilation; (4) vessel thickening (Rudnicka. Birch, 2000) and cell death by *apoptosis* (Kern et al, 2000).

The process of oxidation has been proposed as an adjunct to the mechanistic formation of AGEs from glucose and protein-glucose ketimines. Weiss et al (2000), describe how molecular oxygwn in conjunction with metal catalysts, may bring about the formation of glyoxal and other intermediates prior to the crosslinking of proteins as AGEs. The mechanisms, in fact , remain somewhat speculative.

PART- II

AIM OF STUDY

(1) To analyze the correlation between Diabetic retinopathy status and HbA1c values.

(2) To study the relationship of HDL_2/HDL_3 ratio with Diabetic Retinopathy status.

METHOD OF STUDY

MATERIALS AND METHODS

100 Diabetic patients between the age group of 30 to 60 years of either sex were included in this study. Both type 1 and type 2 diabetic patients were included . 20 normal cases were kept as control. 40 cases were diabetics without retinopathy ,and 60 patients were diabetics with retinopathy.

All the patients were subjected to detailed history and examination including detailed ocular examination, which included refraction ,intraocular pressure measurement, fundus examination, fundus fluorescein camera and angiography.

Scott's classification (years) was used for the grading of diabetic retinopathy. Diabetes in all these patients was confirmed by estimating fasting and post-

prandial blood sugar. The blood samples from over night fasting patients were obtained in EDTA vials (l mg/ ml of blood). Different fractions of lipoprotein were separated by using heparin manganese chloride and sodium dodecyl sulfate double precipitation technique. Total cholesterol and cholesterol content of lipoprotein fractions was estimated by the met by the method of Abell et al. Triglyceride was estimated by the technique of Van Handel and Zilversmit.

SERUM CHOLESTEROL AND HDL SUBFRACTIONS ESTIMATION:

It was done by Wybenga and Pileggi's method using strangen reagent kit. A simple and precise method for measuring HDL-cholesterol subfractions is by a single precipitation followed by homogenous HDL-cholesterol assay. HDL consists of two major subfractions, HDL2 and HDL3. This describes a simple method for assaying HDL subspecies by combining a single precipitation with a direct high density lipoprotein-cholesterol (HDL-C) assay. A precipitation reagent (0.06 ml) containing 1,071 U/ml heparin, 500 mmol/l MnCl2) and 12 mg/ml dextran sulfate was added to a serum (0.3 ml). The sample was incubated and centrifuged at 10,000 rpm for 10 min. HDL3-C was measured by a homogenous HDL-C assay in the supernatant, and HDL2-C was estimated by subtracting the HDL3-C from the direct HDL-C. The HDL3-C and HDL2-C values determined by the precipitation method were identical to those

determined by ultracentrifugation, and there were excellent correlations between the methods in the measurements of HDL3-C and HDL2-C (r = 0.933 and 0.978, respectively; n = 102). The two methods also proved to be highly correlated in the measurement of apolipoprotein A-I and A-II in HDL subfractions. The HDL-C subfractions determined by ultracentrifugation were more closely associated with the homogenous HDL-C assay than with the total cholesterol assay, especially in the hypertriglyceridemic samples.

SERUM TRIGLYCERIDE ESTIMATION: It is based on the following principle. N-heptane iso propanol mixture is used to separate out phospholipids from triglyceride,then triglycerides are hydrolysed by saponification with potassium hydroxide followed by acidification. Glycerol liberated by meta periodate to formaldehyde which is measured calorimetrically by reaction with acetyl acetone ammonia.

ESTIMATION OF Hb1Ac : By columnar method . The caebohydrate moiety of glycosylated haemoglobin is converted into hydroxyl methyl furfural by heating with phosphoric acid.The hydroxymethyl furfural is then incubated with Thiobarbituric acid to give a colored compound which is measured photometrically.

INSTRUMENTS USED

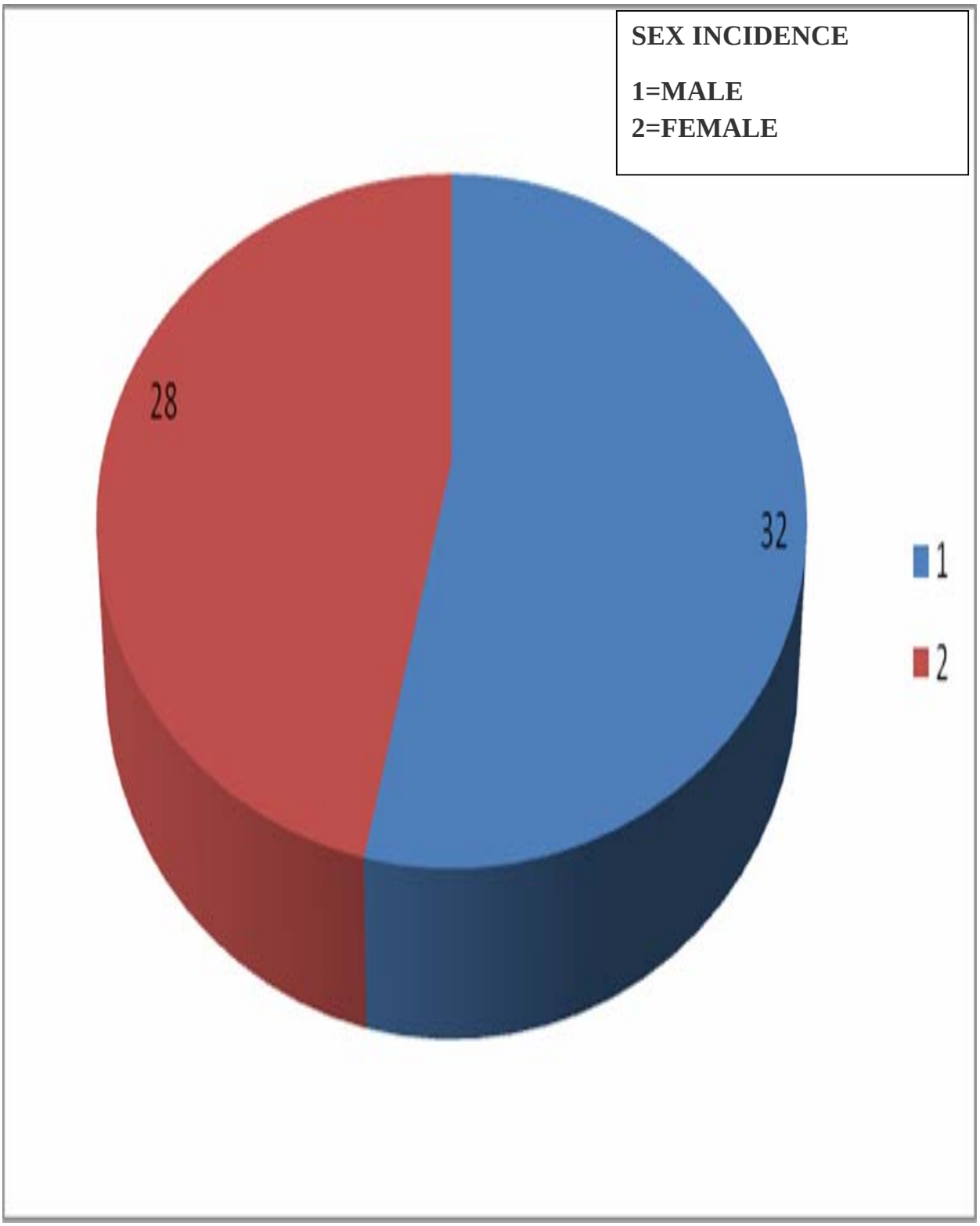
1. Indirect and direct ophthalmoacope
2. Haag Streit Slit lamp
3. Goldmann's applanation tonometer
4. Goldmann's 3 mirror lens
5. Topcon fundus camera for fundus photography

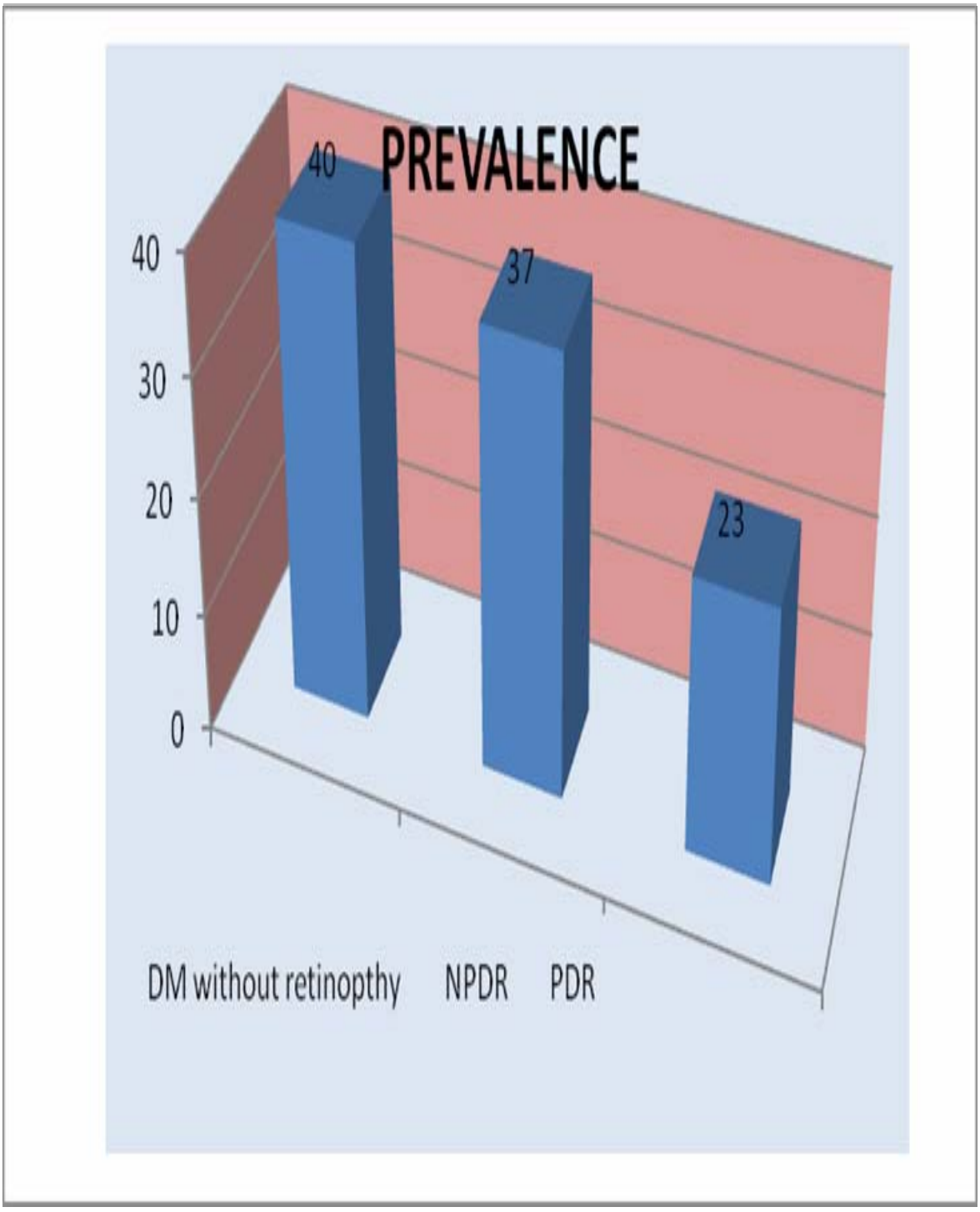
ANALYSIS AND DISCUSSION

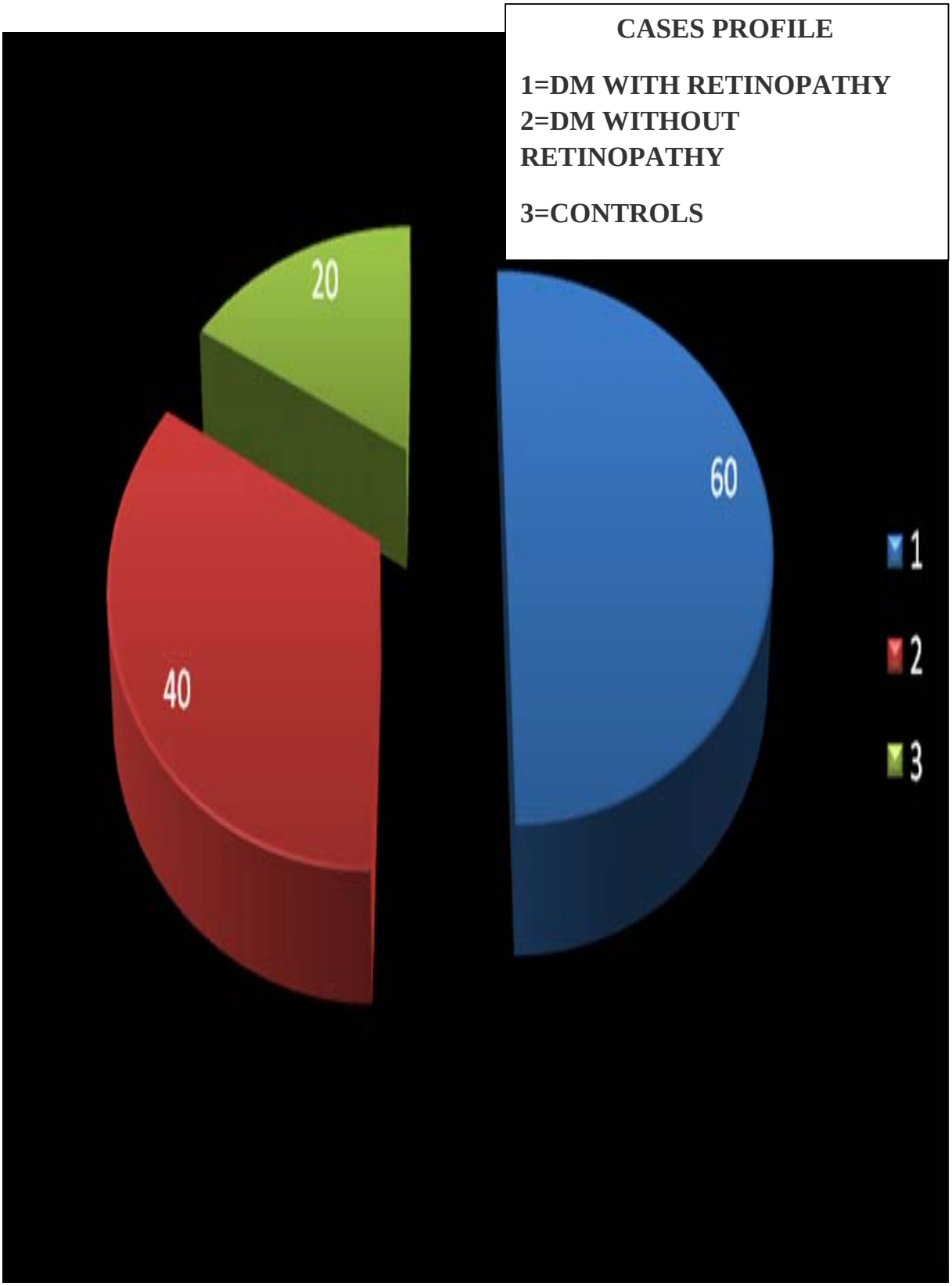
In this analytical study, 100 patients of diabetes mellitus who attended the diabetes clinic in the department of diabetology in Government General Huspital , MMC, Chennai , from November 2006 to February 2007 were taken. The patients chosen were of the age group 30-60 years. . Both type 1 and type 2 diabetic patients were included . 20 normal cases were kept as age matched control. Full detailed ophthalmic examination was carried out on all the patients. Blood analysis for lipid profile , which included HDL_2 and HDL_3 subfractions , Hb1Ac was also done meticulously using standard protocols for laboratory investigations.

Incidence and Prevalence

Nearly 171 million people worldwide have diabetes. This figure is likely to double by 2030. India holds 31.7 million diabetic patients ranking first in the world. This number is projected to increase to 79.4 million by 2030.[2] In India, prevalence of DR has been reported to range from 10.5% to 26.2% This study also reiterated the fact that the incidence of diabetic retinopathy is more in males compared to females . In this study the percentage of diabetic patients without retinopathy is 40 and those with retinopathy is 60. The further breakup of this 60 percent is NPDR 37% and PDR 23%.


SEX INCIDENCE
1=MALE
2=FEMALE
28
32
1
2


PREVALENCE
40
37
23
40
30
20
10
0
DM without retinopthy
NPDR
PDR


CASES PROFILE
1=DM WITH RETINOPATHY
2=DM WITHOUT RETINOPATHY
3=CONTROLS
20
60
40
1
2
3

Prevalence

Diabetes mellitus	**No. of cases**	**Percentage(%)**
DM without retinopathy	40	40
NPDR	37	37
PDR	23	23

Sex incidence

In this study , the percentage of males with diabetic retinopathy is 53.33 and females is 47. This finding correlated with the findings of earlier studies e.g. WEDSR, UKPDS, etc. that the incidence of diabetic retinopathy is more incident in males as compared to females.

Sex	No. of cases with diabetic retinopathy	Percentage**(%)**
Male	32	53.33
Female	28	47

Out of 60 cases , 32 were male and 28 cases were female.

CONTROL CASES TAKEN FOR STUDY

20 age matched control cases were taken for this study. 10 were males and 10 females.

Analysis of Bio-chemical indices :

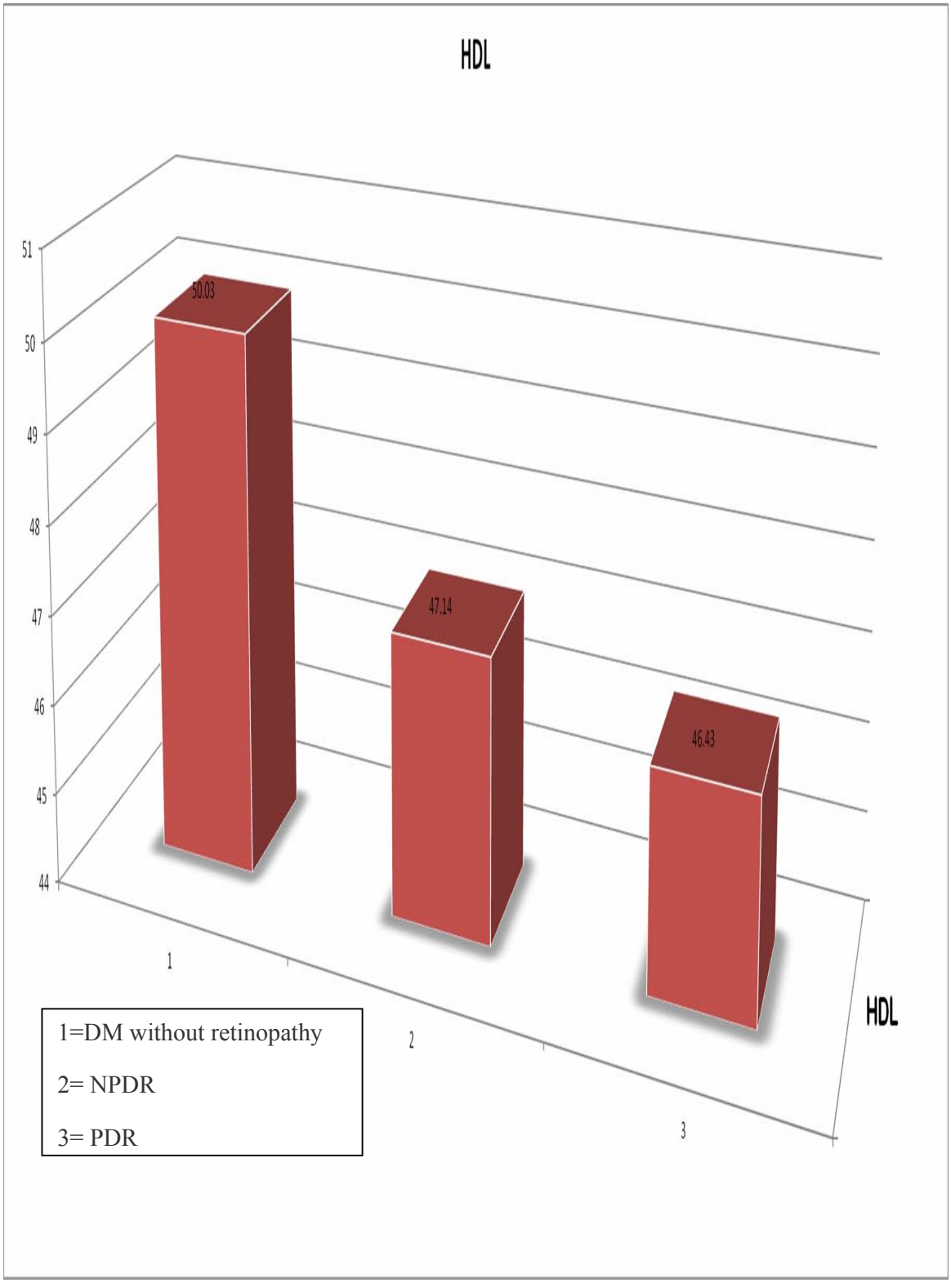
HDL and HDL_2/HDL_3 Subfractions ratio:

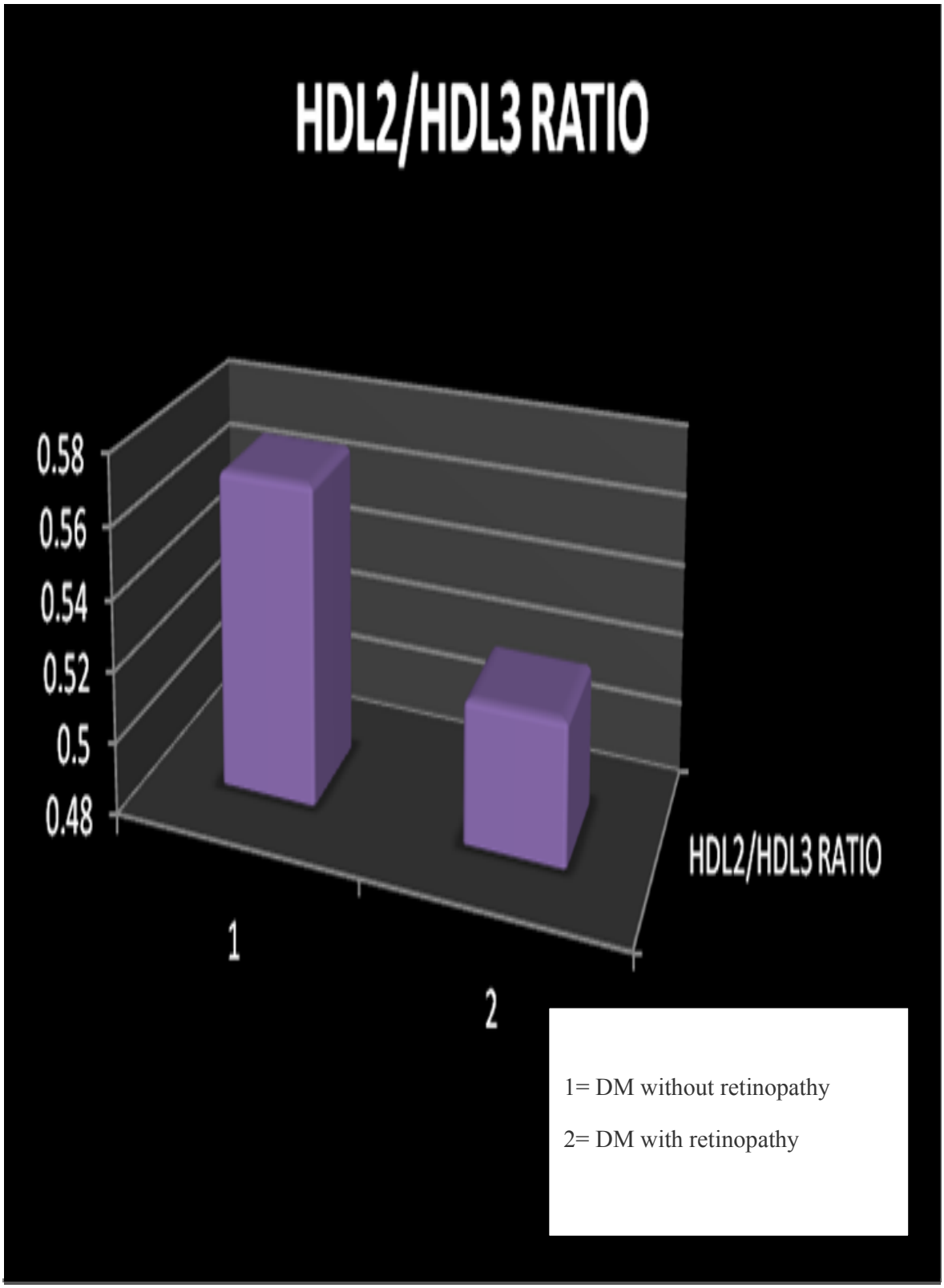
Study suggests that high HDL cholesterol may, independently of glycemic control, prevent the development of microvascular complications in diabetes. These results could be related to antioxidant, antithrombotic, and anti-inflammatory properties of HDL particles . Interestingly, structural modifications of HDL mediated by various mechanisms, including glycation, oxidation, and enzymatic degradation, may affect their functional and atheroprotective properties. This may suggest that not only quantity but also quality of HDL particles play a role in the damage of endothelium.

HDL Values:

	DM without retinopathy	NPDR	PDR
Mean	50.03	47.14	46.43
Standard deviation	7.9	10.5	9.3
P Value	<0.05		
Confidence interval	1.68		

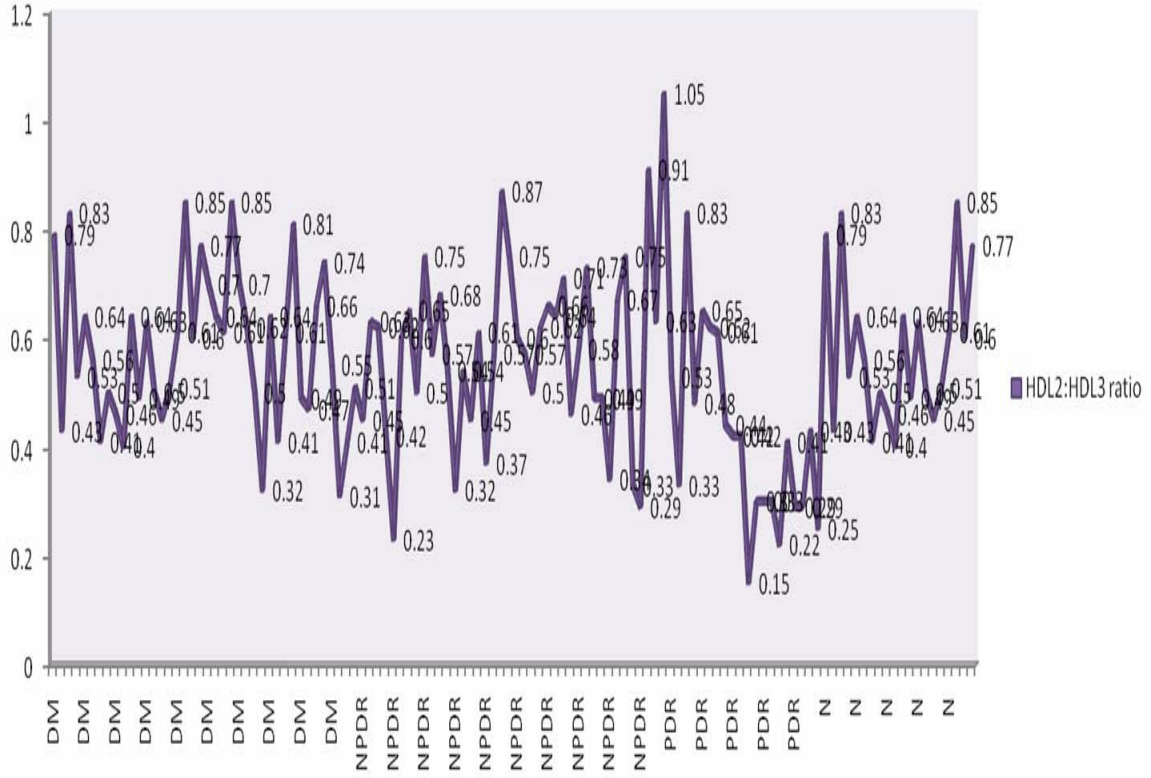
The above values show that HDL Values are abnormal both in DM without and with retinopathy patients.It is 50.03 , 47.14 and 46.43 in DM without retinopathy, NPDR and PDR respectively. It also shows that lower values of HDL in patients with diabetic retinopathy shows a correlation with severity of diabetic retinopathy status . The 'p'value is <0.05 and confidence interval is 1.68, which shows that the data is statistically significant.


HDL
51
50
49
48
47
46
45
44
50.03
47.14
46.43
1
2
3
HDL
1=DM without retinopathy
2= NPDR
3= PDR


HDL2/HDL3 RATIO
0.58
0.56
0.54
0.52
0.5
0.48
HDL2/HDL3 RATIO
1
2
1= DM without retinopathy
2= DM with retinopathy

HDL2:HDL3 ratio

Frequency distribution



HDL_2/HDL_3 Subfractions ratio:

HDL_2/HDL_3 RATIO

	DM without retinopathy	DM with retinopathy
Mean	0.57	0.52
Standard Deviation	0.14	0.18
Confidence interval 'p' value	0.031 <0.05 Significant	

DM without retinopathy	DM with retinopathy	
21	5	HDL_2/HDL_3 ratio N
39	35	HDL_2/HDL_3 ratio ↓

ODD'S Ratio= 3.76

Chi square test: 6.4 'P' value: <0.01

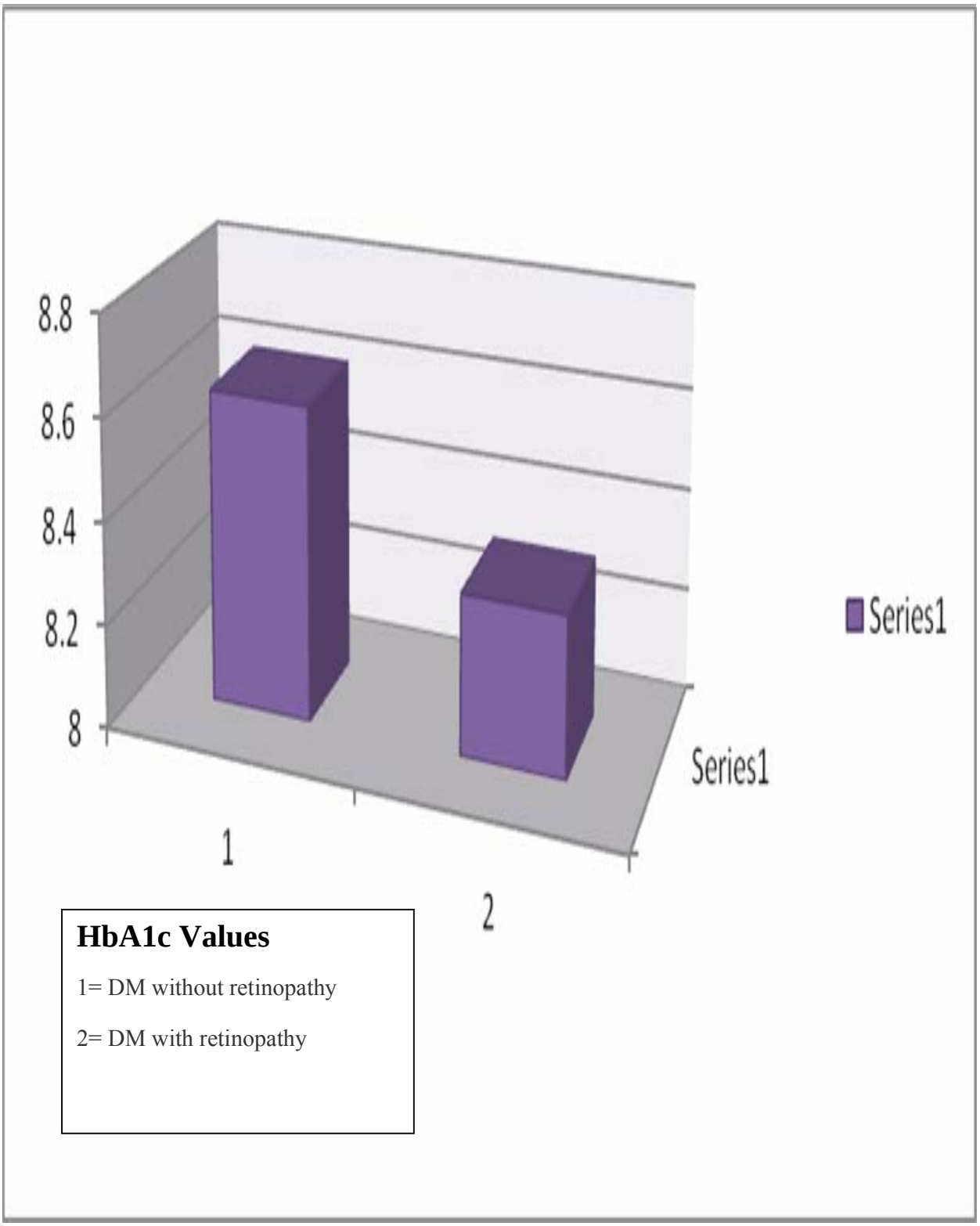
The mean HDL_2/HDL_3 ratio in diabetics without retinopathy is 0.57 and in with retinopathy it is 0.52. This study shows a correlation with the decreased HDL_2/HDL_3 ratio with the severity of diabetic retinopathy status. This is statistically highly significant , 'p' value being <0.05. Moreover the odds ratio of correlation of HDL_2/HDL_3 ratio with developing retinopathy in diabetic patients is shown to be 3.76 , which is a significant finding. The above data was statistically analysed by chi square test which shows that the above findings are not chance findings, 'p' value being <0.01.

HbA1c Values

	DM without retinopathy	DM with retinopathy
Mean	8.615	8.313
Standard Deviation	0.922524407	0.985396189
Confidence interval	0.18	
'p' value	<0.05 Significant	

Chi Square test: 4.1

According to the above data, the mean HbA1c values in patients of DM without retinopathy is 8.615% and in patients of DM with retinopathy is 8.313%. The confidence interval is 0.18. We assessed the HbA1c values in order to assess the control of diabetic status. The slightly lower values of HbA1c in patients of DM with retinopathy could be explained by the fact that there could be a tendency towards more strict glycemic control in these subgroup of patients. As a corollary of the above findings , it can be postulated that the severity of diabetic retinopathy status bears a correlation with the level of glycosylated haemoglobin.



HbA1c Values

1= DM without retinopathy

2= DM with retinopathy

TGL Values(mg/dl)**:**

	DM without retinopathy	NPDR	PDR
Mean	76.77	84.48	92.69
Standard deviation	7	36	55
P Value Confidence interval	<0.05 5.87		

The mean serum triglycerides ($P < 0.05$) were higher in subjects with DR compared with those without DR. After adjusting for age, gender, duration of diabetes, total serum triglycerides were associated with DR After adjusting for HbA_{1c} and body mass index, triglycerides maintained a significant association with DR .

There is a significant association of serum triglycerides with DR. The p Value is <0.05 and the confidence interval is 5.87. This finding also correlates with the earlier study done I,e. the Chennai Urban Rural Epidemiology Study (CURES) Eye Study—2.

TC Values(mg/dl):

	DM without retinopathy	NPDR	PDR
Mean	133.82	148.77	151.33
Standard deviation	13.76	37.17	29.51
P Value Confidence interval	<0.05 4.50		

The mean serum total cholesterol concentrations were higher in subjects with DR compared with those without DR. It is 133.82, 148.77, 151.33 mg/dl in DM without retinopathy, NPDR and PDR respectively. The above finding is statistically significant because p value is <0.05 and the confidence interval is 4.50.

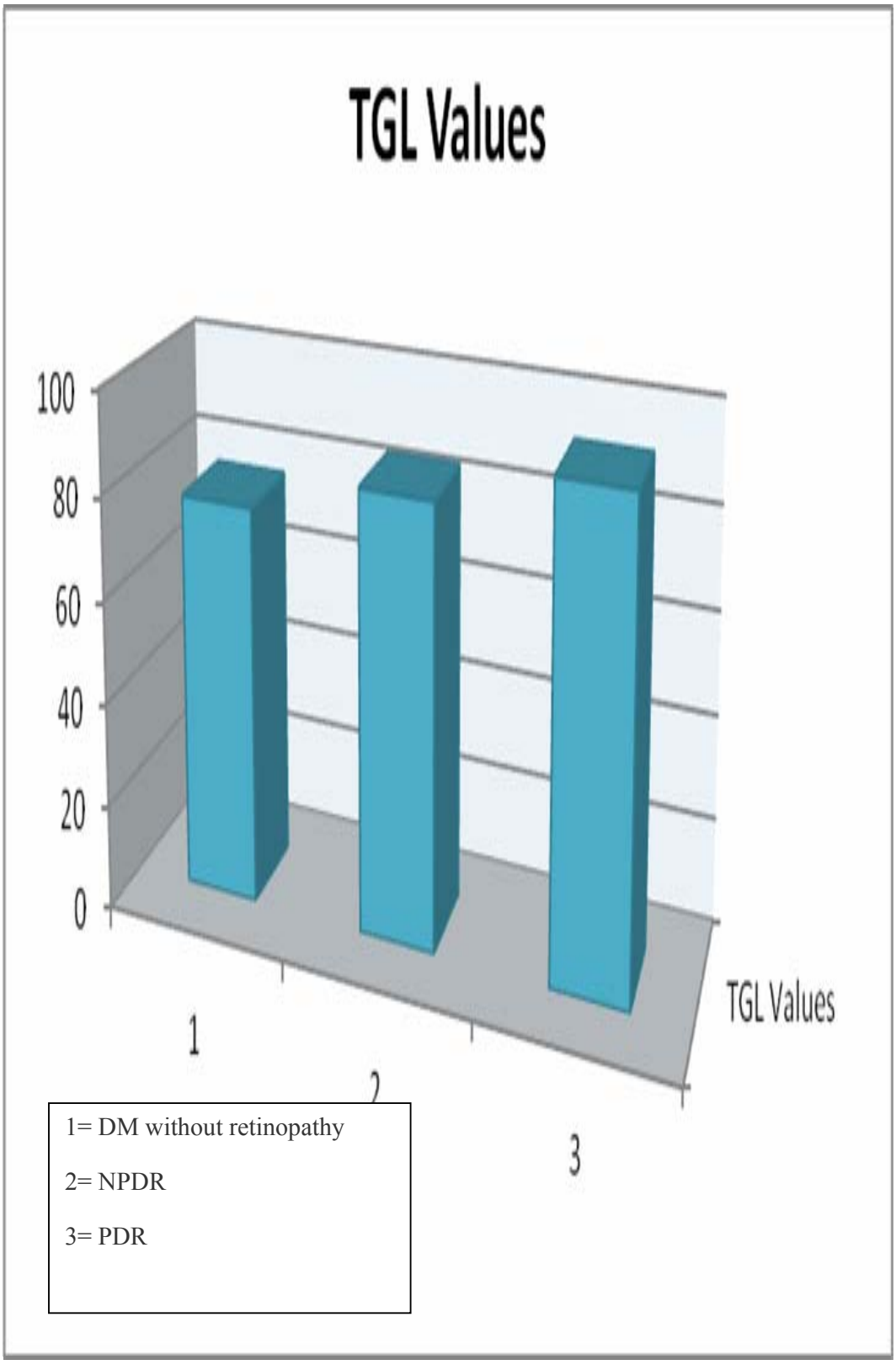
LDL Values (mg/dl):

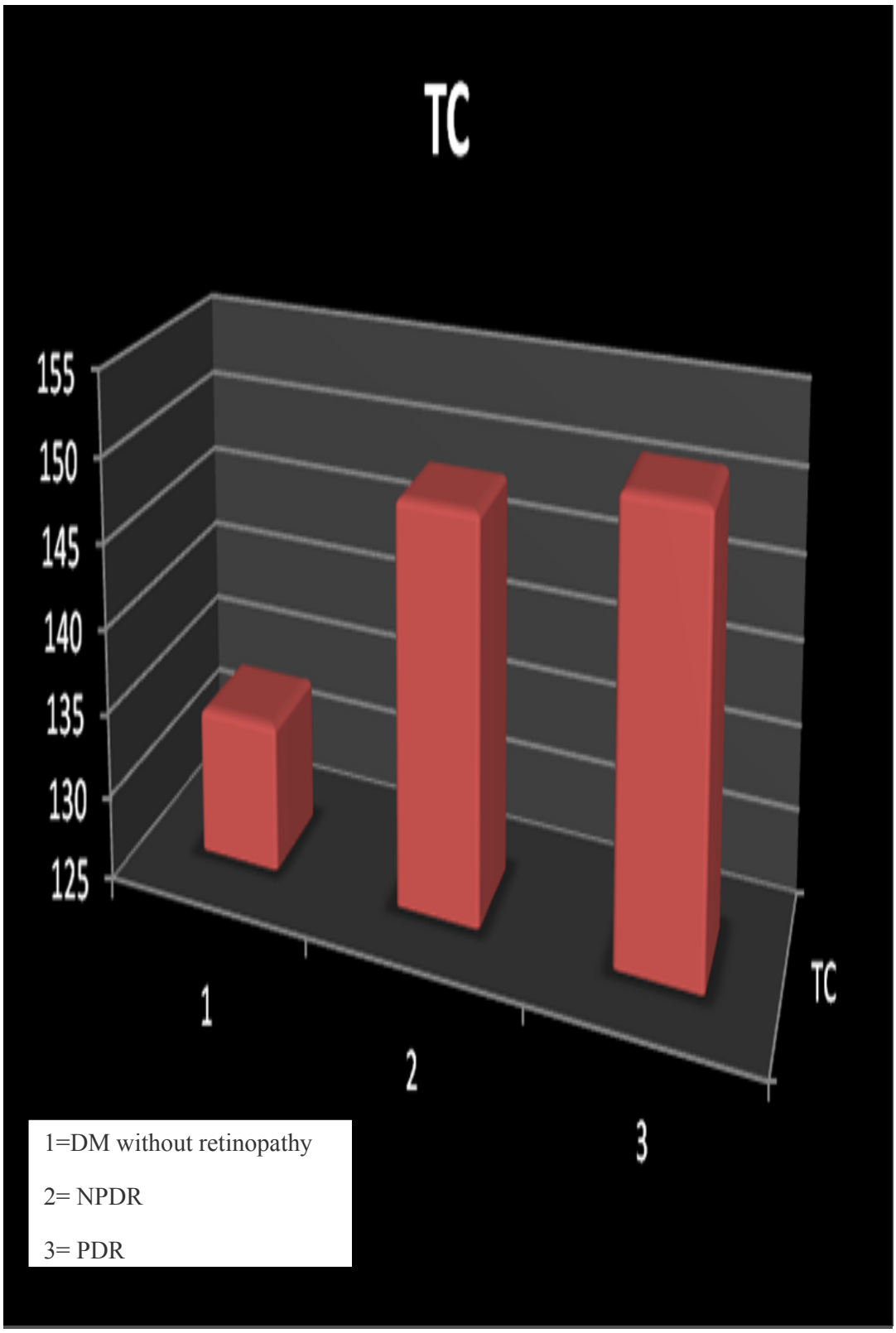
	DM without retinopathy	NPDR	PDR
Mean	68.43	83.82	84.66
Standard deviation	13.80	28.17	25.08
P Value	<0.05		
Confidence interval	4.38		

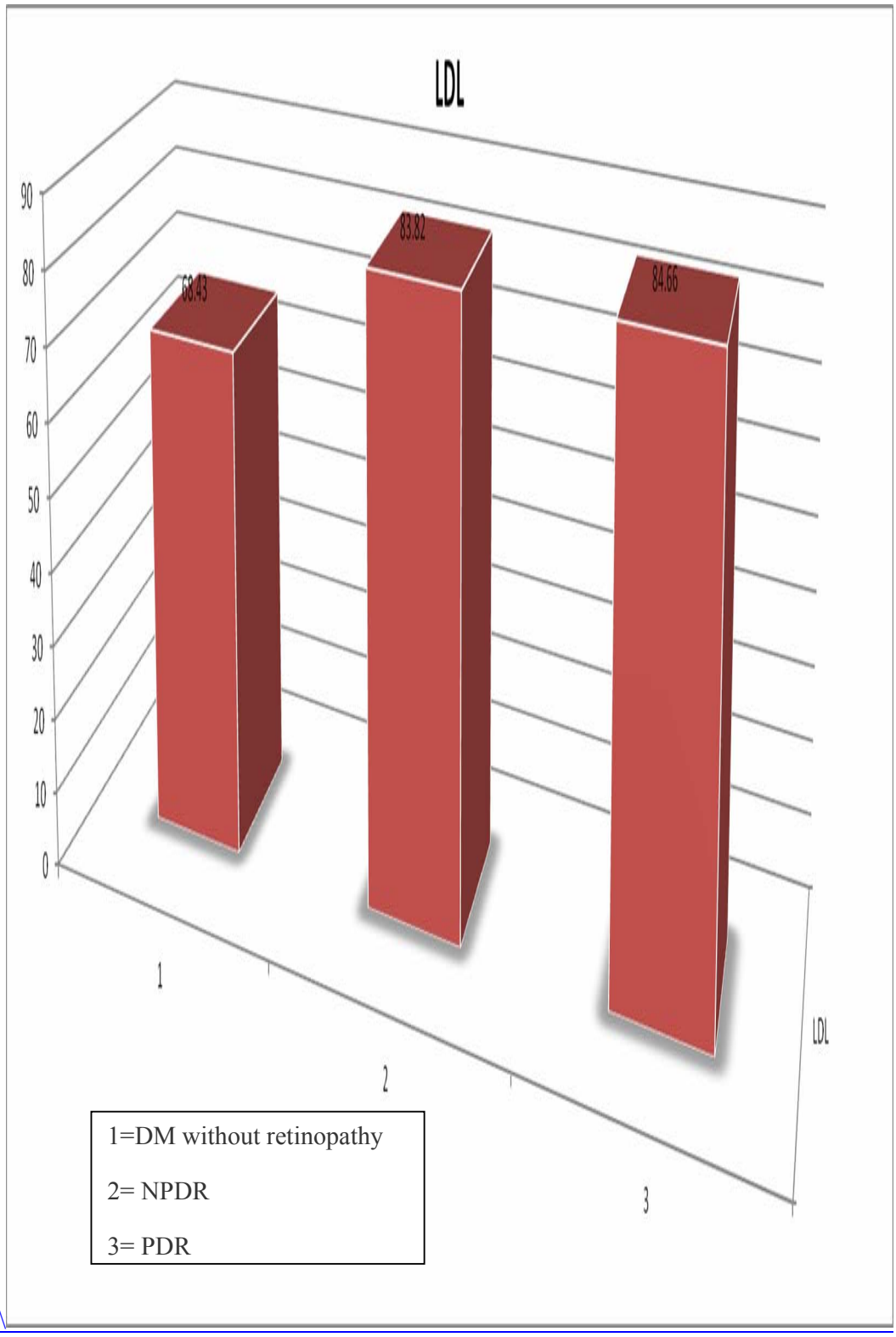
The above data clearly shows that there is a clear correlation between the level of LDL values and the severity of Diabetic retinopathy. The mean LDL values are 68.43 ,83.82 , 84.66 mg/dl in patients of DM without retinopathy, NPDR and PDR respectively. The above finding is statistically significant because p value is <0.05 and the confidence interval is 4.38.

This study revealed the following relevant observations, which could be regarded as novel findings:

1. Significantly lower values of HDL in patients with diabetic retinopathy shows a correlation with severity of diabetic retinopathy status .


TGL Values
100
80
60
40
20
0
1
2
3
TGL Values
1= DM without retinopathy
2= NPDR
3= PDR


TC
155
150
145
140
135
130
125
1
2
3
TC
1=DM without retinopathy
2= NPDR
3= PDR


LDL
90
80
70
60
50
40
30
20
10
0
68.43
83.82
84.66
1
2
3
LDL
1=DM without retinopathy
2= NPDR
3= PDR

\\\\

2. Study suggests that high HDL cholesterol may, independently of glycemic control, prevent the development of microvascular complications in diabetes.

3. This study shows a correlation with the decreased HDL_2/HDL_3 ratio with the severity of diabetic retinopathy status.

4. This may suggest that not only quantity but also quality of HDL particles play a role in the damage of endothelium.

SUMMARY

1. In this study 100 patients of diabetes mellitus who attended the diabetes clinic in the department of diabetology in Government General Hospital , MMC, Chennai , from November 2006 to February 2007 were taken.
2. 40 cases were diabetics without retinopathy ,and 60 patients were diabetics with retinopathy.
3. 20 normal cases were kept as age matched control.
4. **AGE GROUP**

   The patients chosen were of the age group 30-60 years.
5. SEX INCIDENCE

   In this study , the percentage of males with diabetic retinopathy is 53.33 and females is 47. Males are affected more than the females.
6. CLINICAL PROFILE

   40 cases were diabetics without retinopathy ,and 60 patients were diabetics with retinopathy. Of these 60 cases , 37 were of NPDR and 23 were of PDR, i.e. 37% and 23% respectively.

   20 cases were taken from normal age matched population and were kept as controls.

   BIO-CHEMICAL INDICES STUDIED
7. **HDL**

HDL values are abnormal both in DM without and with retinopathy patients. It is 50.03 , 47.14 and 46.43 in DM without retinopathy, NPDR and PDR respectively.

It also shows that lower values of HDL in patients with diabetic retinopathy shows a correlation with severity of diabetic retinopathy status .

8. **HDL_2/HDL_3 Subfractions ratio**

   The mean HDL_2/HDL_3 ratio in diabetics without retinopathy is 0.57 and in with retinopathy it is 0.52. This study shows a correlation with the decreased HDL_2/HDL_3 ratio with the severity of diabetic retinopathy status. The odds ratio of correlation of HDL_2/HDL_3 ratio with developing retinopathy in diabetic patients is shown to be 3.76

   Data was statistically analyzed by chi square test which shows that the above findings are not chance findings, 'p' value being <0.01.

9. **HbA1c Values**

   The mean HbA1c values in patients of DM without retinopathy is 8.615% and in patients of DM with retinopathy is 8.313%. The confidence interval is 0.18. The slightly lower values of HbA1c in patients of DM with retinopathy could be explained by the fact that there could be a tendency towards more strict glycemic control in these subgroup of patients.

10.**TGL Values**

The mean serum triglycerides ($P < 0.05$) were higher in subjects with DR compared with those without DR. It is 76.77 84.48 and 92.69 mg/dl in cases of DM without retinopathy, NPDR and PDR respectively. After adjusting for age, gender, duration of diabetes, total serum triglycerides were associated with DR After adjusting for HbA_{1c} and body mass index, triglycerides maintained a significant association with DR .

11. **TC Values**

The mean serum total cholesterol concentrations were higher in subjects with DR compared with those without DR. It is 133.82, 148.77, 151.33 mg/dl in DM without retinopathy, NPDR and PDR respectively. There is a direct relation between the mean serum total cholesterol concentrations and the severity of diabetic retinopathy. It is statistically significant because p value is <0.05.

12.**LDL Values**

There is a clear correlation between the level of LDL values and the severity of Diabetic retinopathy. The mean LDL values are 68.43 ,83.82 , 84.66 mg/dl in patients of DM without retinopathy, NPDR and PDR respectively. It is statistically significant because p value is <0.05. We can see that the severity of Diabetic retinopathy status is in direct

proportion with the level of LDL values in the different subcategories of diabetic retinopathy patients.

To summarize ,our study suggests that high HDL cholesterol may, independently of glycemic control, prevent the development of microvascular complications in diabetes. These results could be related to antioxidant, antithrombotic, and anti-inflammatory properties of HDL particles . Interestingly, structural modifications of HDL mediated by various mechanisms, including glycation, oxidation, and enzymatic degradation, may affect their functional and atheroprotective properties . This may suggest that not only quantity but also quality of HDL particles play a role in the damage of endothelium.

We assessed the HbA1c values in order to assess the control of diabetic status. As a corollary of the above findings , it can be postulated that the severity of diabetic retinopathy status bears a correlation with the level of glycosylated haemoglobin.

CONCLUSIONS

From this study we were able to arrive at the following conclusions.

1. Males are affected more than the females i.e. the incidence of diabetic retinopathy is more incident in males as compared to females.
2. In India, prevalence of DR has been reported to range from 10.5% to 26.2%
3. In the clinical profile of the patients , NPDR was more prevalent than PDR.
4. This study shows a correlation with the decreased HDL_2/HDL_3 ratio with the severity of diabetic retinopathy status. The odds ratio of correlation of HDL_2/HDL_3 ratio with developing retinopathy in diabetic patients is shown to be 3.76
5. We assessed the HbA1c values in order to assess the control of diabetic status. As a corollary of the above findings , it can be postulated that the severity of diabetic retinopathy status bears a correlation with the level of glycosylated haemoglobin.

6. After adjusting for age, gender, duration of diabetes, total serum triglycerides were associated with DR in direct proportional relation. After adjusting for HbA_{1c} and body mass index, triglycerides maintained a significant direct association with DR .
7. There is a direct relation between the mean serum total cholesterol concentrations and the severity of diabetic retinopathy.
8. The severity of Diabetic retinopathy status is in direct proportion with the level of LDL values in the different subcategories of diabetic retinopathy patients.
9. Structural modifications of HDL mediated by various mechanisms, including glycation, oxidation, and enzymatic degradation, may affect their functional and atheroprotective properties. This may suggest that not only quantity but also quality of HDL particles play a role in the damage of endothelium.

PART- III

BIBLIOGRAPHY

TEXT BOOK REFERENCES

1. Anthony S Fauci, Eugene Braunwald, Kurt J Isselbacher. Harrison's Principles of Internal Medicine.14th edition, volume 2. McGraw-Hill publishers. 1998: 2061-2078.
2. "Diabetes Action now: An Initiative of the World Health Organization & the, International Diabetes Federation" A WHO publication, 2004 pg: 10.
3. Albert & Jakobiec. Principles and Practice of Ophthalmology. 2nd edition, volume 3. W.B. Saunders company, 2000: 1900-1913.
4. "Blindness: vision 2020- control of major blinding disease & disorders", A WHO publication, Feb 2000.
5. Agarwal S, Raman R, Paul PG, Rani PK, Uthra S, Gayathree, McCarty C, Kumaramanickavel G, Sharma T. Sankara Nethralaya-Diabetic Retinopathy Epidemiology and Molecular Genetic Study (SN-DREAMS 1): study design and research methodology, Ophthalmic Epidemiol. 2005 Apr; 12(2): 143-53.

6. Nirmalan PK, Katz J, Robin AL, Tielsch JM, Namperumalsamy, Kim R, Narendran V, Ramakrishnan R, Krishnadas R, Thulasiraj D, Suan E. Prevalence of vitreoretinal disorders in a rural population of southern India: the Aravind Comprehensive Eye Study. Arch Ophthalmol. 2004 Apr; 122(4):581-6
7. Survey of visual impairment in an Indian tertiary eye hospital, Herse P, Gothwal VK, Indian J Ophthalmol. 1997 Sep;45(3):189-93
8. Narendran, R K John, A Raghuram, R D Ravindran, P K Nirmalan, and R D Thulasiraj. Diabetic retinopathy among self reported diabetics in southern India: a population based assessment. Br. J. Ophthalmol., Sep 2002**;** 86**:** 1014 - 1018.
9. Donald S. Fong, Lloyd Aiello, Thomas W. Gardner, et al. Diabetic retinopathy – Position statement. Diabetic care; 26: 226-229, Jan 2003.
10. Rema M, Ponnaiya M, Mohan V. Prevalence of retinopathy in non insulin dependent diabetes mellitus at a diabetes centre in southern India. Diabetes Res Clin Pract. 1996 Sep;34(1):29-36.
11. Pierro L, Brancato R, Robino X, et al. Axial length in patients with diabetes. Retina. 1999;19(5):401-4
12. Liverpool Diabetic Eye Study: Incidence of sight-threatening retinopathy in patients with type 2 diabetes in the Liverpool Diabetic Eye Study: a cohort study. Younis N, Broadbent DM, Vora JP, Harding SP; Lancet. 2003 Jan 18;361(9353):195-200

13. Rema M, Premkumar S, Anitha B, Deepa R, Pradeepa R, Mohan V. Prevalence of diabetic retinopathy in urban India: the Chennai Urban Rural Epidemiology Study (CURES) eye study, I. Invest Ophthalmol Vis Sci. 2005 Jul;46(7):2328-33
14. Sharma R.A Diabetic eye disease in southern India. Community Eye health 1996;9: 56-58.
15. Grading Diabetic Retinopathy from Stereoscopic Color Fundus Photographs – An Extension of the Modified Airlie House Classification. Early treatment diabetic retinopathy study research group. Ophthalmology 1991; 98:786-806
16. United kingdom prospective study, 30 Diabetic Retinopathy at Diagnosis of Non-Insulin-Dependent Diabetes Mellitus and Associated Risk Factors Eva M.Kohner, MD; Stephen J.Aldington, DMS; Irene M.Stratton, MSc; Susan E.Manley, PhD; Rury R.Holman, MD; David R.Mathews, MD; Robert C.Turner, MD; for the United Kingdom Prospective Diabetes Study Arch Ophthalmol. 1998;116:297-303
17. The Wisconsin Epidemiologic Study of Diabetic Retinopathy: XVII. The 14-year incidence and progression of diabetic retinopathy and associated risk factors in type 1 diabetes. Klein R, Klein BE, Moss SE, Cruickshanks KJ. Ophthalmology. 1998 Oct;105(10):1801-15
18. Dandona L, Dandona R, Naduvilath TJ, et al. Refractive errors in an urban population in Southern India: the Andhra Pradesh Eye Disease Study. *Invest Ophthalmol Vis Sci*. 1999;40:2810–2818.

19. Fledelius HC. Is myopia getting more frequent? A cross-sectional study of 1416 Danes aged 16 years+. *Acta Ophthalmol (Copenh)* 1983;61:545–59.
20. Jain IS, Luthra CL, Das T.Diabetic retinopathy and its relation to errors of refraction. *Arch Ophthalmol* 1967;77:59–60.
21. Rand LI, Krolewski AS, Aiello LM, Warram JH, Baker RS, Maki T. Multible factors in the prediction of risk of proliferative diabetic retinipathy. *N Engl J Med* 985;313:1433–8.
22. Horner JF Quoted by Duke Elder S. System of Ophthalmology London: Kimpton 1970:5
23. Granstrom KO. Refraktionsveranderungen bei diabetes mellitus. Acta Ophthalmol(Kbh)1933;11:1-161
24. Duke Elder S Changes in refraction in diabetes mellitus. British journal of ophthalmology 1925;9:167-87
25. Roberts W Rapid lens changes in diabetes mellitus. Am journal of ophthalmology 1951;33:1283-5
26. Refractive change in diabetic patients during intensive glycaemic control Fumiki Okamoto, Hirohito Sone, Tomohito Nonoyama, Sachiko Hommura. Br. J. Ophthalmology 2000; 84:1097-1102
27. Planten J . Physiological optic approach of lens and cataract. Ophthalmologica 1975;171:199-206
28. Feinblum SM Clinical significance of refractive change in diabetes. Optometric weekly 1972:63:199-206

29. Refractive change in hyperglycaemia: hyperopia or myopia; Paul Riordan Eva, Patrica T, Pascoe and Daniel G Vaughan; British journal of Ophthalmology 1982 ,66, 500-505
30. American Academy of ophthalmology (sec11- lens and cataract) pg. 60
31. Paediatric ophthalmology and strabismus: David Taylor and Creig Hoyt: pg 43 & 54
32. Larsen JS The sagital growth of eye I-IV. Acta Ophthalmol(Copenhagen) 1971;49:239-62,427-40, 441-53,873-86
33. The absence of diabetic retinopathy in patients with retinitis pigmentosa: implications for pathophysiology and possible treatment: G B Arden; *Br J Ophthalmol* 366 2001;85:366–370
34. The negative coincidence of retinitis pigmentosa and proliferative diabetic retinopathy. Sternberg P Jr, Landers MB 3rd, Wolbarsht M. Am J Ophthalmol. 1984 Jun;97(6):788-9.
35. Modifying factors related to asymmetric diabetic retinopathy. Dogru M, Inoue M, Nakamura M, Yamamoto M. Eye. 1998;12 (Pt 6):929-33.
36. Occurrence of changes in the eye in diabetic retinopathy with significant myopia Dujić M, Misailović K, Nikolić Lj, Ignjacev M. Srp Arh Celok Lek. 1998 Nov-Dec;126(11-12):457-60.
37. Ocular factors in the incidence and progression of diabetic retinopathy. Moss SE, Klein R, Klein BE. Ophthalmology. 1994 Jan;101(1):77-83.

38. Influence of HLA-DR phenotype and myopia on the risk of nonproliferative and proliferative diabetic retinopathy; Baker RS, Rand LI, Krolewski AS, et al.:Am J Ophthalmol 1986, 102:693–700.
39. A new pressure attenuation index to evaluate retinal circulation. A link to protective factors in diabetic retinopathy; Quigley M, Cohen S:. Arch Ophthalmol 1999, 117:84–89.
40. Chennai Urban Rural Epidemiology Study (CURES) Eye Study—2

PROFORMA

NAME:

AGE:

SEX: F/M

OP/IP NO.

OCCUPATION:

AGE:

PERSONAL HISTORY: SMOKING/ALCOHOLOIC

VEGETARIAN/NON-VEGETARIAN

AGE OF ONSET OF DIABETES:

ANY OTHER DISORDER:

DURATION OF DIABETES:

CONTROL OF DIABETES: MEDICATIONS

COMPLAINTS:

OCULAR EXAMINATION: RE/LE

VISUAL ACUITY

LIDS

CONJ

CORNEA

ANTERIOR CHAMBER

PUPIL

IRIS

LENS

TENSION

RETINOSCOPY

SUBJECTIVE

VISION CORRECTION

FUNDUS

A. DISTANT DIRECT

B. DIRECT

MEDIA/DISC/VESSELS

SLIT LAMP EXAMINATION

SYSTEMIC EXAMINATION

INVESTIGATION

BLOOD PRESSURE

URINE: ALBUMIN/SUGAR/DEPOSITS

TC/DC/ESR/HB

FASTING BLOOD SUGAR

GLYCOSYLATED HAEMOGLOBIN

SERUM TRIGLYCERIDES

SERUM CHOLESTEROL

HDL

HDL_2

HDL_3

FFA: LEAKAGE

AREAS OF CAPILLARY NON PERFUSION

NEOVASCULARISATION

IRMA

DIAGNOSIS:

NAME	AGE/ years	SEX	DURATION/	DIAGNOSIS	FBS(mg%)	HbA1c(%)	TGL (mg/ dl	TC(mg/ dl)	HDL(mg/ dl	LDL(mg/ dl)	HDL3(mg/ c	HDL2(mg/ c	HDL2:HDL3 ratio
Munusamy	32	M	5	DM	260	8.3	62	128	53.6	62	29.9	23.7	0.79
Veeran	31	M	6	DM	180.5	7.6	66.2	140	56.6	70.16	39.5	17.1	0.43
Subramani	40	M	4	DM	110	9.3	66	116	54.4	48.4	29.7	24.7	0.83
Joseph	32	M	3	DM	88.2	10.3	72.4	128	59.4	54.12	38.8	20.6	0.53
Balakondaiya	54	M	4	DM	112	7.6	68	122.6	48.5	60.5	29.6	18.9	0.64
Elumalai	44	M	5	DM	118	8	72	123.6	51.2	58	32.9	18.3	0.56
Chinnaya	43	M	4	DM	103	8.5	81.6	126	54.4	55.28	38.7	15.7	0.41
Yusuf	54	M	5	DM	72.8	10.2	81.6	140.1	51.4	72.38	34.2	17.2	0.5
Govindan	43	M	3	DM	166	9.5	84.8	144.6	43.2	84.44	29.5	13.7	0.46
Rajan	33	M	5	DM	133	7.9	81	141	53.2	71.6	38.12	15.1	0.4
Govindasamy	56	M	7	DM	129	8.9	68.8	128	48.6	65.64	29.7	18.9	0.64
Venkatesan	44	M	5	DM	246	8.9	77.4	148	48.7	83.82	32.7	16	0.49
Moorthy	54	M	6	DM	95	8.5	77.2	106	42.6	47.96	26.2	16.4	0.63
Thirumal	34	M	5	DM	161	6.9	71.7	121	48.9	57.76	32.7	16.2	0.5
Pichai	37	M	4	DM	309	8.1	83.2	129	45.6	66.76	31.4	14.2	0.45
Shiva	51	M	3	DM	127.8	8.9	67.4	138	51.8	72.72	34.2	17.6	0.51
Isac	54	M	5	DM	112.8	8.5	78.5	146	52.9	77.4	32.8	20.1	0.61
Perumal	56	M	3	DM	75	6.9	77.4	152	54.4	82.12	29.4	25	0.85
Rudran	43	M	6	DM	102	8.1	79.2	141	53.8	71.36	33.6	20.2	0.6
Selvam	32	M	3	DM	92	9.4	74.3	121.6	48.9	57.84	27.6	21.3	0.77
Kumar	47	M	5	DM	184.5	9.9	86	127.4	48.4	61.8	28.4	20	0.7
Velu	49	M	3	DM	223	11.2	74.4	108.7	52.8	41.02	32.1	20.7	0.64
Thirumoorthy	35	M	7	DM	173	7.8	68.4	126.4	48.9	63.82	30.4	18.5	0.61
Thirumalai	46	M	8	DM	182	7.7	77.4	141	53.6	71.92	28.9	24.7	0.85
Venkatasamy	56	M	8	DM	105	7.6	71.3	134.7	51.7	68.74	30.4	21.3	0.7
Raju	45	M	8	DM	164.4	9.3	84.4	142	46.3	78.82	28.6	17.7	0.62
Baskaran	34	M	8	DM	103	7.6	88.6	146	45.6	82.68	30.41	15.2	0.5
Chintamani	45	M	6	DM	166	9.5	66.2	128	52.2	62.56	39.4	12.8	0.32
Yellamalai	34	M	4	DM	121	8.2	68.8	112	46.8	51.44	28.5	18.3	0.64
Chinnatha	45	F	6	DM	211	8.3	95.6	124.4	50.6	54.68	35.9	14.7	0.41
Saroja	35	F	7	DM	131	8.4	84.4	126.8	52.4	57.52	32.6	19.8	0.61
Annatha	39	F	5	DM	94	8.3	72.5	146	54.4	77.1	30.1	24.3	0.81
Panchali	40	F	4	DM	133	8.4	88.6	160	42.6	99.68	28.5	14.1	0.49
Govindamma	57	F	7	DM	211	8.4	72.2	128.8	46.6	67.76	31.8	14.8	0.47
Dilli Bai	58	F	5	DM	131	8.3	76.2	142	49.2	77.56	29.7	19.5	0.66
Noorbibi	57	F	7	DM	94	8.6	86	148	48.5	82.3	27.8	20.7	0.74
Kamala	38	F	2	DM	133	8.3	80.9	157.3	46.7	94.42	30.1	16.6	0.55
Anandi	55	F	3	DM	211	9.4	88.6	147.3	42.6	86.98	32.6	10	0.31
Seetha	56	F	5	DM	154	9.6	76.7	109.7	46.7	47.66	33.1	13.6	0.41
Kanthammal	57	F	2	DM	74	9.5	73	156	52.6	88.8	34.8	17.8	0.51
Kamban	54	M	10	NPDR	156	7.7	120	168	53.6	90.4	36.9	16.7	0.45
Vellai	53	M	11	NPDR	160	8.4	91	159	46.6	94.2	28.6	18	0.63
Krishnasamy	56	M	11	NPDR	144	8.2	98	138	46.1	72.3	28.5	17.6	0.62
Rajendran	56	M	13	NPDR	130	8.3	138	151	45	79	31.6	13.4	0.42
Muhamed	51	M	12	NPDR	160	8.7	40	115	41	66	33.2	7.8	0.23
Babu	56	M	12	NPDR	144	8.5	50	114	42.6	59.2	26.7	15.9	0.6
Suresh	58	M	9	NPDR	162	8.3	80	147	53.6	77.4	32.4	21.2	0.65
Yesu	59	M	8	NPDR	154	8.2	141	110	30.7	51.1	20.4	10.3	0.5
Durairaj	54	M	12	NPDR	115	8.4	49	100	37.7	52.5	21.5	16.2	0.75
Basha	53	M	13	NPDR	123	8.3	44	126.4	32.1	85.5	20.4	11.7	0.57
Palani	56	M	12	NPDR	209	8.3	45	106	49.6	48	29.6	20	0.68
Swaminathan	57	M	11	NPDR	262	8.2	79	132	43.1	73.1	28	15.1	0.54
Muniyandi	56	M	11	NPDR	179	8.3	48	87	30.7	46.7	21	6.7	0.32
Nagaraj	55	M	10	NPDR	180	8.1	96	133	43.5	70.7	28.3	15.2	0.54
Andiappan	55	M	9	NPDR	150	8.6	98	138	36.1	72.4	24.9	11.2	0.45
Chuppan	50	M	12	NPDR	170	8.2	72	134.6	54.3	65.9	33.7	20.6	0.61
Vishnu	49	M	13	NPDR	132	8.6	177	239	37.8	165.8	27.6	10.2	0.37
Chittan	48	M	12	NPDR	159	8.2	82	136	44.3	75.3	28.3	16	0.57
Ganesan	47	M	12	NPDR	102	8.3	111	203	46.3	134.5	24.7	21.6	0.87
Velan	48	M	13	NPDR	146	8.6	65	108	38.1	56.9	21.8	16.3	0.75
Rama	49	F	12	NPDR	143	8.3	54	179	64	105	40.3	24	0.6
Susheela	55	F	11	NPDR	123	8.5	148	208	66.7	111.7	42.6	24.1	0.57
Karpagam	60	F	11	NPDR	112	8.3	68	164	70	80.4	46.7	23.3	0.5
Nalini	47	F	13	NPDR	76	10.9	147	246	55.3	161	34.1	21.2	0.62
Sheela	54	F	12	NPDR	92	9.4	98	143	35.5	88	21.4	14.1	0.66
Muniammal	56	F	11	NPDR	184	6.2	46	116	47.5	59.3	28.9	18.6	0.64
Rukmani	58	F	11	NPDR	223	7.6	76	145	41.5	88.3	24.3	17.2	0.71
Govindamma	48	F	11	NPDR	154	7.4	65.5	120.3	44.5	62.7	30.5	14	0.46
Selvi	58	F	11	NPDR	105	8.6	130	152	31.6	94.4	20	11.6	0.58
Nagammal	54	F	10	NPDR	106	8.2	42	180	67.1	104.5	38.7	28.4	0.73
Lalitha	54	F	11	NPDR	115	8.6	134.7	147	48.4	71.6	32.4	16	0.49
Sarada	56	F	12	NPDR	143	9.4	67	134	48.7	71.9	32.6	16.1	0.49
Kamakshi	54	F	12	NPDR	157	9.9	55.2	206	51.9	143	38.7	13.2	0.34
Sowmya	55	F	13	NPDR	167	7.4	44	120	49.7	61.5	29.8	19.9	0.67
Gowri	57	F	12	NPDR	134	7.6	62	160	53.2	94.4	30.4	22.8	0.75
Neela	53	F	11	NPDR	145	8.9	47	126	40.5	76.4	30.4	10.1	0.33
Rasathi	53	F	12	NPDR	165	10.8	120	168	52.5	91.5	40.8	11.7	0.29
Meenu	52	F	11	NPDR	167	7.1	82	194	70	83	36.7	33.3	0.91
Nithyanand	56	M	14	PDR	180	8.6	68	130	49.3	67.1	30.2	19.1	0.63
Mari	58	M	15	PDR	154	7.6	88	195	68.5	108	33.4	35.1	1.05
Nagaiyah	59	M	16	PDR	134	7.5	63	134	49.7	71.6	32.4	17.3	0.53
Mehamood	59	M	16	PDR	102	8.1	78	148	45.8	79.6	34.5	11.3	0.33
Gopal	58	M	17	PDR	104	8.4	148	167	58.3	79.1	31.8	26.5	0.83
Pichandi	57	M	18	PDR	166	6.9	64	140	51.4	75.8	34.7	16.7	0.48
Sethu	58	M	18	PDR	122	8.3	52	117	43.2	63.4	26.2	17	0.65
Kumar	60	M	16	PDR	211	8.7	49	114	42	62.2	26	16	0.62
Ganesan	58	M	17	PDR	131	9.4	284	149	45	49	27.9	17.1	0.61
Seethammal	56	M	15	PDR	94	8	88.8	214.4	41.6	154.6	28.9	12.7	0.44
Perumal	55	M	19	PDR	133	7.6	184.5	168.5	34.4	67.2	24.3	10.1	0.42
Andiappan	55	M	18	PDR	211	7.3	118	153	35.3	94	24.8	10.5	0.42
Ranga	58	M	18	PDR	154	7.1	128	208	42.3	140	36.9	5.4	0.15
Padmanaban	59	M	18	PDR	74	11.7	46	138	44.7	84	34.3	10.4	0.3
Dhanam	59	F	19	PDR	156	7.1	55	122	41.5	69.5	31.9	9.6	0.3
Ahalya	58	F	19	PDR	160	10.6	86	201	63.2	120.6	48.6	14.6	0.3
Nandini	57	F	17	PDR	115	7.4	63	143	46.9	83.5	38.6	8.3	0.22
Sheela	57	F	17	PDR	114	8.2	53	129	46.2	72.2	32.7	13.5	0.41
Seethammal	56	F	19	PDR	134	8.6	45	131	43.6	78.4	33.8	9.8	0.29
Kamalammal	56	F	20	PDR	179	7.2	77	141	40.8	84.8	31.7	9.1	0.29
Rajathi	59	F	16	PDR	82	7.4	114	158	43.5	91.7	30.5	13	0.43
Kasthuri	56	F	15	PDR	178	7.6	87	128	44.3	66.3	35.4	8.9	0.25
Ekambaram	44	M	NA	N	75	4.3	62	128	53.6	62	29.9	23.7	0.79
Venkatesh	55	M	NA	N	68.3	4.5	66.2	140	56.6	70.16	39.5	17.1	0.43
Velmurugan	34	M	NA	N	84.4	4.5	66	116	54.4	48.4	29.7	24.7	0.83
Thangavel	45	M	NA	N	66.4	4.5	72.4	128	59.4	54.12	38.8	20.6	0.53
Thirumalai	23	M	NA	N	72	4.6	68	122.6	48.5	60.5	29.6	18.9	0.64
Natesan	54	M	NA	N	69	4.6	72	123.6	51.2	58	32.9	18.3	0.56
Gyanavel	45	M	NA	N	71	4.7	81.6	126	54.4	55.28	38.7	15.7	0.41
Venkatasan	34	M	NA	N	72.4	4.7	81.6	140.1	51.4	72.38	34.2	17.2	0.5
Dakshinamoo	55	M	NA	N	80.9	4.6	84.8	144.6	43.2	84.44	29.5	13.7	0.46

Sheela	57	F		17	PDR	114	8.2	53	129
Seethammal	56	F		19	PDR	134	8.6	45	131
Kamalammal	56	F		20	PDR	179	7.2	77	141
Rajathi	59	F		16	PDR	82	7.4	114	158
Kasthuri	56	F		15	PDR	178	7.6	87	128
Ekambaram	44	M	NA		N	75	4.3	62	128
Venkatesh	55	M	NA		N	68.3	4.5	66.2	140
Velmurugan	34	M	NA		N	84.4	4.5	66	116
Thangavel	45	M	NA		N	66.4	4.5	72.4	128
Thirumalai	23	M	NA		N	72	4.6	68	122.6
Natesan	54	M	NA		N	69	4.6	72	123.6
Gyanavel	45	M	NA		N	71	4.7	81.6	126
Venkatasan	34	M	NA		N	72.4	4.7	81.6	140.1
Dakshinamoc	55	M	NA		N	80.9	4.6	84.8	144.6
Govinda	54	M	NA		N	82.2	4.7	81	141
Polachi	53	F	NA		N	64.4	4.4	68.8	128
Rani	56	F	NA		N	72.6	4.5	77.4	148
Shakuntala	33	F	NA		N	78	4.6	77.2	106
Indrani	32	F	NA		N	75	4.6	71.7	121
Subbammal	31	F	NA		N	68	4.8	83.2	129
Anusuya	56	F	NA		N	80	5	67.4	138
Kamakshi	42	F	NA		N	66	5.1	78.5	146
Sarada	43	F	NA		N	66	3.9	77.4	152
Rasathi	44	F	NA		N	67	3.7	79.2	141
Neela	43	F	NA		N	66	3.8	74.3	121.6

INDEX TO MASTER CHART

OP/IP NO. = OUTPATIENT / INPATIENT NUMBER

SEX: F= FEMALE M=MALE

N= NORMAL

DM= DIABETES MELLITUS

NPDR= NONPROLIFERATIVE

DIABETIC RETINOPATHY

PDR= PROLIFERATIVE DIABETIC RETINOPATHY

FBS= FASTING BLOOD SUGAR

HbA1c= GLYCOSYLATED HAEMOGLOBIN

TGL= TOTAL TRIGLYCERIDES

TC= TOTAL CHOLESTEROL

HDL = HIGH DENSITY LIPOPROTEIN

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ABBREVIATIONS

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LIST OF SOME OPERATIONS PERFORMED DURING THE COURSE OF STUDY

Sl. No.	Name	Age	Sex	OP/IP NO.	Diagnosis	Date of Surgery	Type of Surgery
1.	Thangavel	60	M	68034	RE- MC, LE-IMC	23.08.06	RE-ECCEwith PCIOL
2.	Krishnammal	57	F	69034	LE- MC	20.09.06	LE-ECCEwith PCIOL
3.	Chinnaraj	65	M	406787	LE-MC	27.09.06	LE-ECCEwith PCIOL
4.	Vadivu	40	F	402253	RE-MC LE-IMC	11.10.06	RE-ECCEwithPCIOL
5.	Pathu	55	M	69887	LE-MC	18.10.06	LE-ECCEwithPCIOL
6.	Krishnan	54	M	407503	BE-IMC	25.10.06	BE-ECCEwithPCIOL
7.	Rani	59	F	16651	RE-MC LE-IMC	08.03.07	RE-ECCEwithPCIOL
8.	Lakshmi	65	F	15725	RE-HMC LE-IMC	15.03.07	RE-ECCEwithPCIOL
9.	Ramu	66	M	15999	LE-IMC	22.03.07	LE-ECCEwithPCIOL
10.	Joseph	55	M	22658	LE- Sec. Phacolytic Glaucoma	29.03.07	LE-Lens Removal
11.	Shanti	71	M	32544	LE-IMC	05.04.07	LE-ECCEwithPCIOL
12.	Subramani	70	M	28437	BE-IMC	19.04.07	RE-ECCEwithPCIOL
13.	Gajpati	60	M	412151	LE-IMC	21.04.07	LE-ECCEwithPCIOL
14.	Ahmad	55	M	412881	RE-MC	26.04.07	RE-ECCEwithPCIOL
15.	Pattamal	57	F	413106	BE-IMC	04.05.07	RE-ECCEwithPCIOL
16.	Loganathan	65	M	32288	LE-MC	07.05.07	LE-ECCEwithPCIOL
17.	Rajan	60	M	27159	RE-MC LE-IMC	11.05.07	RE-ECCEwithPCIOL
18.	Kausalya	50	F	31873	BE-MC	25.05.07	RE-SICSwithPCIOL
19.	Dhanalakshmi	50	F	31878	LE-PSC	28.05.07	LE-SICSwithPCIOL
20.	Periammal	70	F	33645	BE-MC	01.06.07	RE-ECCEwithPCIOL
21.	Kausalya	60	F	33702	RE-MC	04.06.07	RE-SICSwithPCIOL
22.	Pannaimmal	65	F	417201	BE-IMC	08.06.07	LE-SICS with PCIOL
23.	Parsaran	70	M	412714	RE-Chronic Dacryocystitis	24.09.07	RE-Dacryocystorhinostomy
24.	Saroja	65	F	415022	LE-Pterygium	23.04.08	LE- Pterygium excision
25.	Vridhammal	60	F	426519	RE-IMC	05.05.08	RE- SICS with PCIOL