Dissertation on

# " A CROSS-SECTIONAL STUDY TO DETERMINE THE ROLE OF IRIS FLUORESCEIN ANGIOGRAPHY IN CHRONIC DIABETIC PATIENTS BEFORE CATARACT SURGERY "

*Submitted in partial fulfillment of requirements of*

**M.S. DEGREE**

**BRANCH –III (OPHTHALMOLOGY)**

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**MADURAI MEDICAL COLLEGE**

**MADURAI**


**The Tamilnadu Dr.M.G.R. Medical University**

**CHENNAI, TAMILNADU**

**MAY, 2018**

## CERTIFICATE

This is to certify that this dissertation entitled **"A CROSS-SECTIONAL STUDY TO DETERMINE THE ROLE OF IRIS FLUORESCEIN ANGIOGRAPHY IN CHRONIC DIABETIC PATIENTS BEFORE CATARACT SURGERY"** is the bonafide original work of Dr. S. Murali Krishnan , in partial fulfillment of the requirement for M.S.,(Branch III) Ophthalmology examination of the Tamilnadu Dr.M.G.R. Medical university to be held in May 2018.

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## CERTIFICATE FROM GUIDE

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I also declare that this bonafide work / a part of this work was not submitted by me / anyone else, for any award, for Degree / Diploma to any other University / Board either in India / abroad. This is submitted to The Tamilnadu Dr. M. G. R. Medical University, Chennai in partial fulfillment of the rules and regulations for the award of Master of Surgery degree Branch -III (Ophthalmology) to be held in May 2018.

**Place:** Madurai (Dr. S.MURALI KRISHNAN )

**Date:**

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# INTRODUCTION

Since the basic studies of Novotny and Alvis in early ninteen sixtees, (1,2) fluorescein angiography has been applied routinely for the examination of the chorio-retinal vasculature of retina. However, such studies have been performed on iris vasculature since 1968, when Jensen and Lundbaek(3) succeeded in photographing vessels of the human iris after an intravenous injection of fluorescein. In the subsequent years, many angiographic iris examinations have been performed on patients with different ophthalmic and general diseases, the best known authors being Friedburg and Kottow.(4-8)

In diabetic patients the whole vasculature of the eye can be affected by microangiopathy; iridopathy and retinopathy being the severest. The advanced forms of diabetic retinopathy (DR) and/or diabetic iridopathy (DI) contraindicates many ophthalmic surgical procedures. The high level of neovascular complications in diabetic patients and the higher risk of neovascular glaucoma following vitrectomy(2) and cataract extraction, (7) is well known. (8) Thus any abnormalities of the iris and retina must be carefully assesed before any surgical manipulation in order to avoid complications.

Sometimes, unfortunately, DR is not detectable because of opacity of the optical media. In such cases, iris fluorescein angiography (IFA) is the only way to evaluate diabetic microangiopathy and hence to make an indirect assessment of the Retinal status. (19-22)

To date, the relationship between iridopathy and retinopathy in diabetes has not been clearly elucidated. This study aims at determining the degree of correlation between severity of DI and DR and the former's sensitivity and specificity in predicting the DR status in patients with dense cataract obscuring the view of the retina. Before going into the details of the study proper lets briefly glance through the relevant anatomy and pathophysiology of uvea,retina and their vasculature.

## IRIS ANATOMY

### GROSS APPEARANCE

The iris is the most anterior portion of the uvea. It lies in the frontal plane of the eye between the anterior and posterior chamber, bathed on both surfaces by the aqueous. It is continuous peripherally with the anterior aspect of the mid point of the ciliary body and subsequently get inserted into ciliary body and the scleral spur , contributing to the bounderies of the anterior chamber angle.

The diameter of the iris is approximately 12 mm, and its circumference 38 mm. It is thickest *(0.6* mm) at the collarette and thinnest at the iris root (0.5mm).

The pupil pierces the iris diaphragm slightly below and nasal to its centre, but lying on the optical axis. The pupillary margin rests on the anterior surface of the lens and thus it lies in a plane anterior to the iris root.

Embryologically, the iris can be divided into three layers; two anterior layers and a posterior layer. The anterior layers are otherwise called 'mesenchymal'.

## SUPERFICIAL MESENCHYMAL LAYER

The superficial mesenchymal layer is shorter than the deeper layer and extends from the ciliary border to the collarette, which forms a dentate fringe, separated to a varying degree from the middle layer. This layer gives the ciliary portion of the iris its colour. It contains the iris crypts, bounded by the trabeculae of the collarette, which are the remains of obliterated vessels that passed to the pupillary membrane during embryonic life.

## DEEP MESENCHYMAL LAYER

The deep mesenchymal layer extends from the ciliary border to the pupillary edge. In lightly pigmented irides it has a radial fibrillary appearance and is transparent, so that the deeply pigmented ectodermal layer is visible through it. The superficial mesenchymal layer glides freely over it. It does not participate greatly in movements of the rest of the iris.

The sphincter encircles the pupil being innervated mainly by parasympathetic nerve endings and constricts the pupil on contraction (miosis). The dilator muscle fibres run radially; innervation is by the sympathetic and its contraction dilates the pupil (mydriasis). These muscles show a reciprocal innervation.

**COLOUR**

Iris colour is determined mainly by the melanocytes in the stroma and anterior border layer. In brown iris the melanocytes are profuse and well pigmented. In the blue iris there is a paucity of melanocytes and while the longer wavelengths of light are absorbed, the shorter wavelengths in the blue region of the spectrum are back-scattered or reflected. The stroma of the blue iris contains amelanotic cells whose non-pigmented granules are of unknown composition.

The albinotic iris is pale and buff coloured because of the absence of pigmented melanocytes. With increasing levels of illumination the iris takes on a pinkish colour because light traversing the sclera and pupil transilluminates the iris from behind. Iris colour is inherited; brown- dominant trait, blue- recessive trait. In Caucasians the iris is blue at birth because of a paucity of stromal melanocytes acquiring an adult colouration by 3-5 months. In the black and brown races, there is a denser stroma and pigmented melanocytes, so that at birth the iris appears a slate grey. In some individuals there is a segmental

variation of iris colour in the same eye or the colour may be different between the two eyes (heterochromia).

**THE POSTERIOR LAYER:**

It embryologically originates from the neuroectodermal layer (continuation of the outermost and innermost layers of the retina) and is further divided into the following 2 layers:

**ANTERIOR EPITHELIUM AND DILATOR MUSCLE (DILATOR PUPILLAE)**

The anterior epithelium is about 12.5 micrometer thick with an apical portion which adjoins the posterior epithelium and a basal portion abutting the stroma, whose cellular processes arc specialised to form the smooth muscle-dilator pupillae. It is derived from the outer layer of the optic cup.

**POSTERIOR PIGMENT EPITHELIUM**

The posterior pigment epithelium is a layer of cells derived from the internal layer of the optic cup. The epithelial cells are heavily pigmented that cytoplasmic details are difficult to make out except in albinotic or bleached preparations.

The well-developed desmosomes between the lateral and apical surfaces of these two epithelial layers provide a tight adhesion between them and therefore stresses generated by pupil movement (by myoepithelial contraction), are distributed evenly across the epithelium. When posterior synechiae

(inflammatory adhesions between iris and lens) are ruptured, the epithelial fragments remaining adherent to the lens capsule contains both layers.

## MACROSCOPIC APPEARANCE

### ANTERIOR SURFACE

The anterior surface of the iris is generally richly textured, but in the darker races, where iris pigment is increased, the surface is smooth and velvety and the texture is masked.

### COLLARETTE

The collarette consists of a series of trabeculae forming an interrupted circular ridge. It lies about 1.6 mm from the pupillary margin and divides the surface into an outer ciliary zone and an inner pupillary zone, which often differ in colour. The iris is slightly thickened at the collarette (0.6 mm), which overlies an incomplete vascular circle (circulus vasculosus iridis minor).

### FUCHS' CRYPTS

The iris surface has a trabecular structure most exaggerated in the pupillary zone and collarette region where there are deficiencies in the superficial layers. Large, pit-like depressions are termed Fuchs' crypts. Similar, smaller crypts occurring at the iris periphery and are best seen by gonioscopy.

### PUPILLARY RUFF

The posterior epithelial layers of the iris extend forward at the pupil margin as the pupillary ruff, which are crenated due to the forward extension of the radial folds of the posterior iris surface.

## IRIS SPHINCTER

In blue irises or where the stroma is atrophic, the iris sphincter is visible as a straw -coloured, flat circular strap-like muscle, 0.75 mm wide, encircling the pupil. The central part of the ciliary zone is smooth, in the periphery several contraction furrows occur, concentric with the pupil, which deepen as the pupil dilates. There is less pigment at the base of a furrow, which is best seen in a dark iris with a small pupil (Fuchs).

## POSTERIOR SURFACE

The posterior surface of the iris is dark brown and smooth and displays various radial and circular furrows.

**1.Schwalbe's contraction folds**

**2.Schwalbe's structural furrows**

**3.Circular furrows**

## PITS

Distinct pits found scattered over the pigment epithelium represent desmosomal structures in the posterior epithelial layer.

Thus to summarize the iris has 4 layers from anterior to posterior:

1. anterior border layer;

2. stroma and sphincter muscle;

3. anterior epithelium and dilator muscle;

4. posterior pigmented epithelium.

**AND HISTOLOGICALLY:**

**ANTERIOR BORDER LAYER**

The anterior border layer is a condensation of connective tissue and pigment cells derived from the anterior stroma. **Fibroblasts** predominate this region. It has gap junctions, intermediate junctions and discontinuous tight junctions. It is absent at crypts and thinned at contraction furrows. It is thickest in the pupillary zone and at the periphery of the ciliary zone. This layer is responsible for the colour of the iris, is thin in the blue iris and thick and densely pigmented in the brown iris.

**STROMA**

The stroma consists of a loose collagenous network containing:

• the sphincter pupillae muscle;

• the vessels and nerves of the iris;

• cellular elements: fibroblasts, melanocytes, clump

cells and mast cells.

Lets elaborate about the vessels alone here:

**BLOOD VESSELS**

They are oriented radially with a slightly sinuous course, which allows them to accommodate to the pupillary movements.

They are visible as pale streaks in blue iris in the stroma and their course can be demonstrated by fluorescein angiography. The arteries arise mainly from the major arterial circle of the iris (an anastomosis which lies in the ciliary

body, anterior to the ciliary muscle).Some arteries also arise directly from the anterior ciliary arteries after they have pierced the sclera to reach the ciliary body. Their calibre diminishes rapidly, close to their entry into the iris stroma. They then form a series of vascular arcades.

Complete tenotomy in macaques and baboons is found to reduce anterior segment blood flow by 70 to 80%. Angiographic studies of iris ischaemia following rectus muscle tenotomies clarify that the degree of collateral supply from the major circle of the iris is not great.The iris arteries resemble those of the major circle, which has a muscularis but no internal elastic lamina. The iridial vessels in the primates have found to have a homogeneous structure, and lack the usual organization into arteries, capillaries and veins found in other tissues. The entire vascular network is formed instead by vessels of differing diameters but identical fine structure. Freddo and Raviola have suggested that this could bethe reason behind the lack of a clear-cut filling pattern of arterioles, capillaries and venules, and the absence of a distinct venous phase in human iris angiograms which are typical of retinal angiograms.

Thus, this difference reflects the absense of smooth muscle cells, from vessels of arterial or venous size. Only the capillaries, whose calibres lie between 10 and 15 micrometer, may be correctly designated as such, while arterioles, postcapillary venules and venules cannot be distinguished. But still for convenience the terms 'arteriole' and 'venule' will continue to be used in this

text for the pre- and postcapillary vessels. The basal structure of the iridial vessel wall in the thus has follows:

1. A continuous layer of endothelial cells resting on a basal lamina. These cells exhibit blunt intraluminal protrusions and thin basal lamellae.
2. A discontinuous layer of pericytes lies between two thick layers of basal lamina, which derives from both cellular layers. Their processes interdigitate with those of the endothelial cells through fenestrations in the basal lamina.
3. There is no smooth muscle layer. Instead there is an adventitia containing fibroblasts, melanocytes and occasional macrophages arranged in one or two layers. This creates a distinctive tubular arrangement which helps in the adaptation of vessels to iris movement.

The inner zone is positive for type **VI** collagen and contains fine fibrils which connect the basement membrane with the outer sheath. The arterioles have a heavy tissue adventitia, the venules a thinner one. Larger veins lie in the anterior stroma while those near the dilator are smaller. The venous collector channels traverse the ciliary body to reach the venous system at the ciliary plexus.

**The vascular endothelium**

The vascular endothelium of the human iris is not fenestrated. Freeze fracture studies have shown that the endothelial cells of the iris vessels have two types of intercellular junction: zonular tight junctions ,and gap junctions.

Zonulae occludens form a complex network of anastomosing and branching strands that seal the intercellular cleft. Gap Junctions are rare along the intercellular cleft.

**The pericytes**

The pericytes of the iris vessels are similar to those found elsewhere, including ocular vessels such as in the retina. They exhibit a variable complement of filaments subjacent to the adluminal plasma membrane (facing the lumen). An asymmetrical distribution of plasmalemmal vesicles is concentrated at the abluminal surface similar to the small vessels of the retina, corneal limbus and myocardium.

The endothelial cells and associated pericytes are invested with a basal lamina which is approximately 0.5-3 micrometer wide. Outside this zone is a zone of sparse, longitudinally oriented collagen 7 micrometer wide, surrounded by a granular ground substance and a further connective tissue layer 10 micrometer in width. Larger capillaries have a more continuous layer of pericytes; and a thicker basal lamina.

**Nerves**

The iris nerves are derived from the long and short ciliary nerves accompanying the corresponding arteries, pierce the sclera around the optic nerve, and run forwards between choroid and sclera to the ciliary plexus. Here, numerous branches arise, largely unmyelinated and showing many gangliform enlargements. Their fibres form plexuses (a) in the anterior border layer

(possible sensory), (b) around the larger blood vessels and (c) anterior to the dilator pupillae.

They supply nerve filaments to all layers except the posterior pigmented epithelium. The dilator muscle receives a sympathetic innervation and the sphincter muscle a parasympathetic innervation. But adrenergic and cholinergic innervation has been shown in both muscles.

## MOVEMENT OF FLUID AND SOLUTE ACROSS THE IRIS

It is well known that the anterior surface of the iris and its stroma are freely accessible to the diffusion of fluid and solute from the aqueous humour. In this respect, the anterior and posterior chambers of the eye have different permeability properties. The anterior chamber has leaky channels by which water may leave either by diffusion across the corneal endothelium, the iris or ciliary body stroma, or by pressure-dependent bulk flow via the conventional drainage pathway or uveoscleral system. The posterior chamber is completely secluded by the impermeable epithelia of the iris and the ciliary body. The iris pigment epithelium also pumps out anions of the posterior chamber.

The features of the capillaries of the iris and ciliary body are different, the ciliary capillaries being permeable and the iris capillaries impermeable to tracer materials such as horseradish peroxidase. Thus, in normal conditions, only tiny amounts of plasma proteins reach the anterior chamber by way of the iris

vessels, although protein (via the fenestrated ciliary vessels) will have access to the anterior chamber at the iris root.

The continuous, non-fenestrated vascular endothelium prevents the entry of proteins and tracer molecules (including Sodium fluorescein dye) from the vessel lumen into the iris stroma in the normal eye .With inflammation (e.g. iritis) this barrier breaks down and allows protein to pass into the aqueous, where it becomes visible by slit lamp microscopy as an aqueous flare.

Though the retinal vessels have similar permeability characteristics to the iris capillaries, they respond differently to inflammatory mediators in that the iridial vessels become leaky to intravenous carbon particles or thorotrast after exposing to histamine, whereas the retinal vessels do not.

## THE UVEAL VASCULATURE

### ARTERIES OF THE UVEAL TRACT

The arterial supply is divided into two more or less distinct parts: the anterior and long posterior ciliary arteries supply the iris and ciliary body and the anterior choroid is supplied by recurrent branches of the anterior ciliary arteries, perforating branches of the anterior ciliary arteries, and branches of the ciliary intramuscular artery; the short posterior ciliary arteries supply most of the choroid.

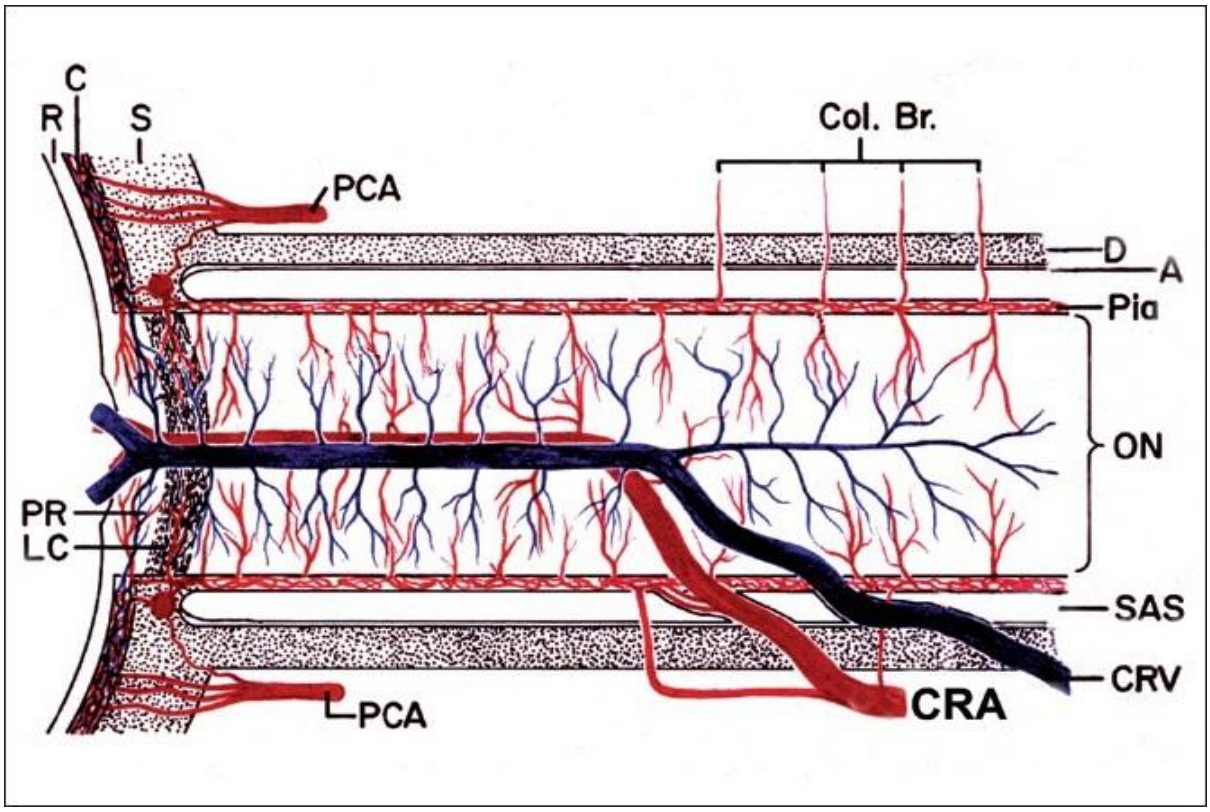
The ciliary arteries supply the whole of the uveal tract, the sclera, limbus and its adjacent conjunctiva, and comprise:

1. the medial and lateral posterior ciliary arteries;

2. the short posterior ciliary arteries;

3. the long posterior ciliary arteries;

4. the anterior ciliary arteries.




**MEDIAL AND LATERAL POSTERIOR CILIARY ARTERIES**

One medial and one lateral posterior ciliary artery arise from the ophthalmic artery while it crosses the optic nerve in the orbit. There is an occasional superior posterior ciliary artery. These arteries divide into 10-20 branches which run forward,surround the nerve, and pierce the eyeball around

it. While most constitute the short ciliary arteries, one medial and one lateral branch become the long posterior ciliary arteries.

**SHORT POSTERIOR CILIARY ARTERIES**

The majority, and the largest of the short posterior ciliaries, after giving branches to the sclera, pierce it in the region temporal to the optic nerve and overlying the macula. The scleral canals are short and directed almost anteroposteriorly. The space around the vessels contains loose tissue which is a prolongation of the suprachoroid. The short posterior ciliary arteries are formed by the second- and third-order divisions of the posterior ciliary arteries, close to the optic nerve head. There are more numerous, distal branches, and a smaller number of paraoptic branches, closer to the optic nerve head. The smaller, paraoptic arteries supply the peripapillary choroid and a vertical trapezoid strip of choroid above and below the optic nerve head either directly, or indirectly through branches of the anastomotic circle of Zinn and Haller. The circle also supplies the retrolaminar part of the optic nerve.

In the absence of this circular anastomosis, its place is taken by small branches of the paraoptic short ciliary arteries, which lie within the sclera and supply portions of the optic nerve head and sometimes the adjacent retina.
The branches of the circle of Haller and Zinn are as follows:
1.Recurrent pial branches: four to seven of these arise from each segment, or may arise from two or three larger trunks. Small branches are given off to the retrolaminar nerve.

2.The recurrent choroidal branches supply the immediate peripapillary choroid, and extend toward the equator as straight vessels superiorly and inferiorly. Small centripetal branches of these arteries, and others from the choroid itself, also supply the laminar and retrolaminar regions of the optic nerve head. Arteriolo-arteriolar anastomoses occur between the components of the circle and the pial and recurrent choroidal arteries.

3.The distal short posterior ciliary arteries supply adjacent triangular areas of choroid whose apices are located approximately at the site of entry of each distal bundle of vessels. One of these vessels on the nasal and temporal side becomes the long posterior ciliary artery and the temporal of these only gives origin to a recurrent branch directed towards the posterior pole.

The supply of the anterior choroid from the short posterior ciliary arteries is supplemented by branches from the long posterior ciliary, the ciliary muscular arteries and perforating branches of the anterior ciliary arteries in the vertical meridian.

The short posterior ciliary arteries lie in the outer layer of the choroid (Haller's layer) and give rise on their deep surface to the choroidal arterioles, which are in the intermediate layer (of Sattler). At the peripheral border a few sub branches of the choroidal arterioles cross the disc margin to supply its prelaminar part. Recurrent branches also contribute to the pial supply.

## LONG POSTERIOR CILIARY ARTERIES

The nasal and temporal long posterior ciliary arteries pierce the sclera on each side of the optic nerve somewhat anteriorly and interiorly than the short ciliary arteries. Each passes forwards through the sclera in a very oblique canal about 4 mm long and then bends inwards at 45° to reach the interior of the eye. Each artery is accompanied by a ciliary nerve.

The arteries reach the suprachoroidal space and run forwards in the horizontal meridian.

The long posterior ciliary arteries bifurcate into the anterior choroid (or sometimes within the ciliary muscle}, and after further divisions form the major arterial circle of the iris, for which they are the predominant supply. In all sectors anastomoses occur between the branches of the anterior ciliary and long posterior ciliary arteries. Twigs from the anterior ciliary arteries supply the peripheral choroid as recurrent choroidal arteries, the canal of Schlemm and limbal sclera.

## ANTERIOR CILIARY ARTERIES

The anterior ciliary arteries are derived from the arteries to the four recti which pass within their substance. Usually two arteries emerge from each tendon, except that of the lateral rectus which carries only one. These arteries, about 1.5 mm from the limbus, divide into deep (scleral) and superficial (anterior episcleral) branches. The former dip almost directly inwards through

short scleral canals, to enter the ciliary muscle, where they join the intramuscular circle and give off some direct branches to the iris and recurrent choroidal arteries to the peripheral choroid.

The point of scleral entry is often marked by pigment. The anterior episcleral arteries run forward and form an irregular, episcleral arterial circle whose anastomotic channels may be superficial or deep. The episcleral arterial circle gives rise to branches supplying the sclera, limbus, perilimbal conjunctiva and iris via deep branches to its major circle.

It should also be noted that the anterior ciliary arteries supply the ciliary muscle, the iris, and the episclera. It is therefore easy to understand why inflammation of the iris or ciliary body is associated with dilatation of episcleral vessels at the limbus (ciliary flush), a classic sign of anterior uveitis.

Multiple disinsertions of the rectus muscle during squint surgery deprive the ciliary muscle (and iris) of its anterior ciliary arterial supply and may give rise to anterior segment ischaemia. In the same way, during retinal detachment surgery, a tight encircling band placed around the globe may impair the blood supply to the ciliary body and iris by interfering with the long posterior ciliary supply to the major arterial circle. Vortex vein compression may also contribute to anterior ischaemic syndrome

## ARTERIAL SUPPLY OF THE CILIARY BODY AND IRIS

As noted earlier, the major circle of the iris is formed predominantly by the long posterior ciliary arteries, while the intramuscular circle of the ciliary muscle is formed by the penetrating branches of the anterior ciliary arteries.

## CIRCULUS IRIDIS MAJOR

The circulus iridis major is really located in the ciliary body, anterior to the circular part of the ciliary muscle and anterior to the muscular circle. The arteries of the ciliary muscle are numerous and dichotomize to form a dense capillary plexus.

The veins anastomose extensively and drain into the venae vorticosae. They are internal to the ciliary muscle.

## ARTERIES OF THE IRIS

The arteries of the iris arise from the circulus major, often with those to the ciliary processes. There is also a supply from the perforating branches of the anterior ciliary arteries. They enter the iris at the attachments of the ciliary processes, usually several to each process (Leber) and in intervals between the peripheral crypts. Anastomosing occasionally, they converge radially from ciliary to pupillary margin. In pupillary miosis their course is straight, but they

become sinuous as the pupil dilates. Like the veins, their walls are thick in comparison with their calibre.

The vessels are visible as radial streaks united with each other here and there. They are more visible in blue irides than brown and are apparent only in the ciliary part. Dense iridial pigment obscures them in coloured races, and blood is only slightly visible in albinotic eyes. At the collarette, a few anastomoses occur, which, with corresponding venous anastomoses, make an incomplete vascular Circle, the circulus arteriosus iridis minor. Most vessels reach the pupillary margin where, after breaking up into capillaries, they bend round into the veins.

**CAPILLARY PLEXUS**

A dense capillary plexus surrounds the sphincter muscle and another, less dense plexus is anterior to the dilator. In the ciliary region the capillary plexus is less dense and is sparse or absent in the anterior limiting layer.

**STRUCTURE OF IRIDIAL VESSELS**

These vessels are usually said to have a thick and hyaline adventitious coat. The arteries and veins are distinguished not by the thickness of the adventitia, which is proportional to the size of the vessels, but by the structure of the inner tube, which is much thicker in the arteries.

These have a media of circular non-striated muscle cells, which can be followed to the capillaries, and elastic fibres in the intima which reach almost as far.

The arterial wall shows four layers of cells: (1) endothelial cells, with nuclei elongated in the axis of the vessel; (2) muscle cells, with nuclei at right-angles to this axis; (3} loosely packed media with palestaining fibrocytes and collagen; and (4) fibrous adventitia.

The iris capillary endothelium has a thick ,often multilayered basal lamina, outside which are numerous round or oval bodies. Pericytes also exist outside the basal lamina. The endothelial cell borders are not fenestrated and *are* joined together by tight junctions, impermeable to protein tracers.

## VENAE VORTICOSAE (POSTERIOR CILIARY VEINS)

There are usually four veins (two superior and two inferior), which pierce the sclera obliquely on each side of the superior and inferior rectus muscles about 6 mm behind the equator of the globe. No veins leave the eye in the region where the posterior ciliary arteries enter (except, very rarely, in myopic eyes).

### Anterior tributaries

The anterior tributaries of the vorticose veins come from the iris, the ciliary processes, the ciliary muscle and anterior region of the choroid.

### Veins of the ciliary processes

These pass backwards as a series of parallel anastomosing vessels in the pars plana to the inner side of the ciliary muscle to reach the choroid and join the venae vorticosae.

**Veins of the ciliary muscle**

These mostly pass back to join the parallel veins from the ciliary processes. A few, however, pass forwards and pierce the sclera to join the anterior ciliary veins.

**Iris veins**

The veins of the iris run like the arteries, anastomose with each other, and at the ciliary border enter the ciliary body to join the veins of the ciliary processes and so to the venae vorticosae.

In humans there is little communication between adjacent territories of vortex veins and that the watershed between the four drainage areas roughly forms a Maltese cross centred on the disc .

The two superior vorticose veins open into the superior ophthalmic either directly or via its muscular or lacrimal tributaries. The two inferior veins open into the inferior ophthalmic, or into its anastomotic connection with the superior ophthalmic vein.

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**ANTERIOR CILIARY VEINS**

The anterior ciliary veins are, like the arteries, tributaries of the muscular veins. Because they drain only the ciliary muscle, they are smaller than the

corresponding arteries. Thus the arteries and veins of the uveal system of vessels do not correspond either in number, course or mode of branching.

Moreover, the arteries are often larger than the veins, which is unusual elsewhere. The veins, like those of the retina, have no valves.

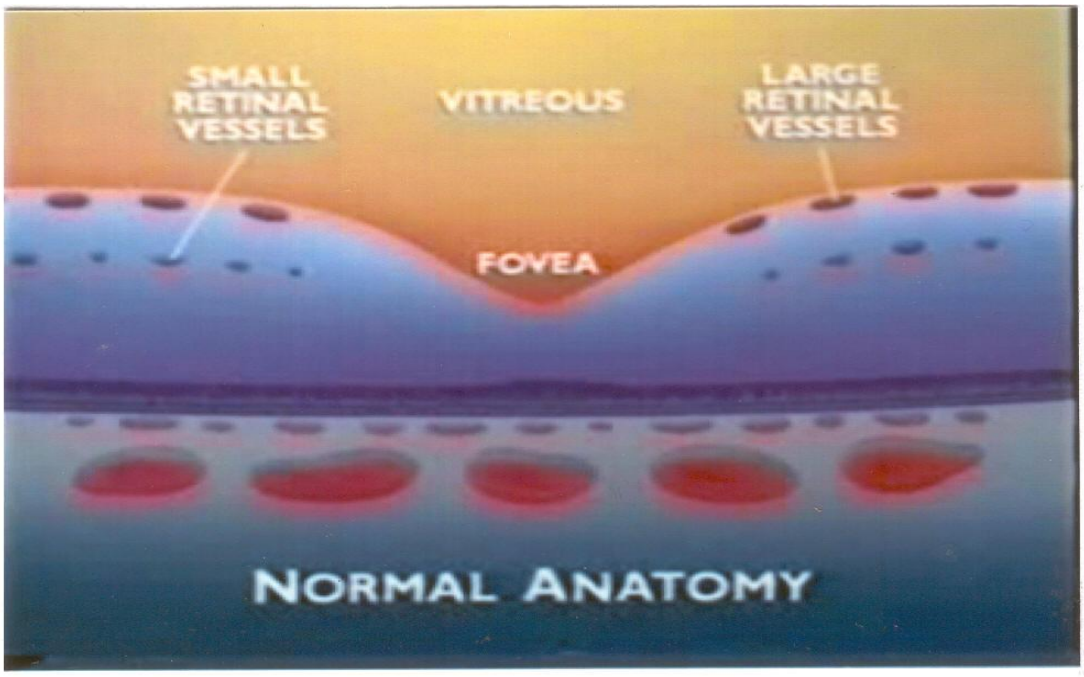
## UVEAL CIRCULATION AND ITS PECULIARITIES

The extraction rate of the retinal vessels is much higher than that of the choroidal vessels, and the oxygen saturation of retinal venous blood is about 60% in human retinal veins by reflective densitometry.

On this basis, it appears that the choroid, and also the anterior uvea, is perfused at a rate which exceeds its nutritive needs. It has been suggested that the high uveal blood flow performs a thermoregulatory function, for instance offsetting heat loss from the anterior surface of the eye, and preventing overheating of the outer retina during exposure to bright light. It may also buffer the ocular pressure rise induced by external pressure, as when rubbing the eyes, because blood is expressed from the venous side of the system.

## VASCULAR SYSTEM OF RETINA

It has two systems of blood supply. The Central retinal system consists of the central retinal artery, central retinal vein, their 4 branches and tributaries respectively,arterioles,capillaries and venules. The posterior ciliary system consists of the posterior ciliary vessels and the choriocapillaries.



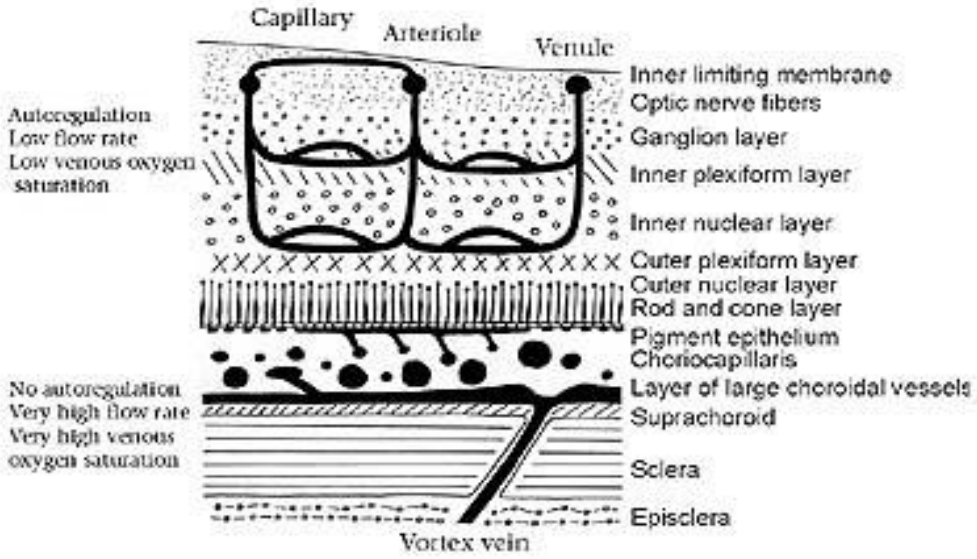

**Central retinal artery :** it is a branch of ophthalmic artery

- ⦿ lies superficially in nasal part of cup.
- ⦿ covered by glial tissue(connective tissue meniscus of kuhnt)
- ⦿ here it divides to 2 branches.
    - superior and inferior papillary branch.
- ⦿ nasal and temporal branch.
- ⦿ Dichotomous branching over retina till ora serrata
- ⦿ Nasal branch - radial
- ⦿ Temporal branch - sweep to avoid macula.
- ⦿ Retinal vein is temporal to retinal artery
- ⦿ Arteries - bright red
- ⦿ Veins - purple red
- ⦿ A:V - 2:3

- course of veins & arteries is similar but not identical &avoids excessive shadowing of rods and cones
- Retinal artery become progressively narrower and thinner as it spreads to periphery.
- Luminal diameter of the artery,
- 120microns – larger posterior vessels
- 8-15microns– periphery.
- Arteries lie in nerve fibre layer or ganglion cell layer just below the internal limiting membrane.
- At AV crossing- indent down to Outer plexiform layer or Outer nuclear layer..
- Retinal arterioles give rise to plexus of capillaries- arranged in two layers

1.nerve fibre and ganglion cell layer.

2.Inner nuclear layer

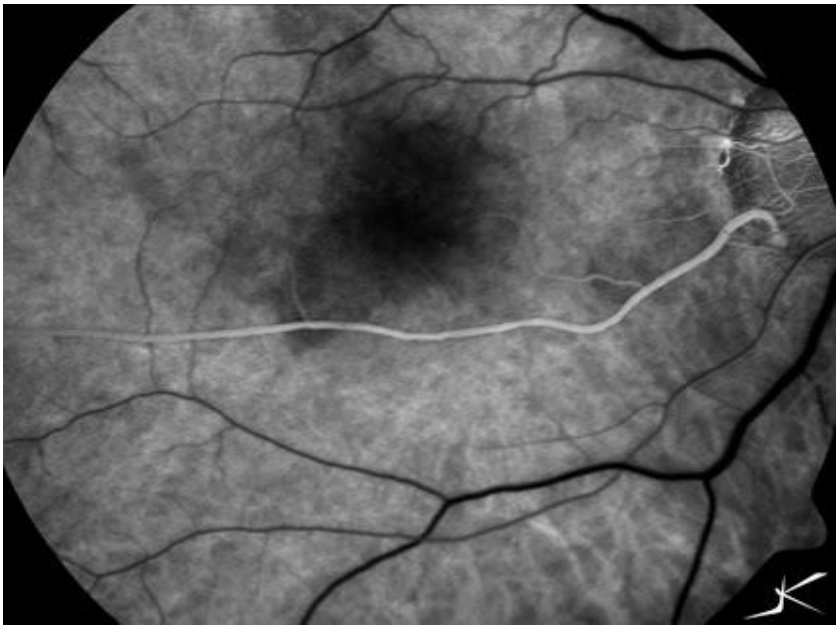


**VEINS**

- Vein lumen-150micrometer diameter at optic disc
- <20 micrometer at the equator.
- Four layers of smooth muscle cells- replaced by pericytes.
- It lacks contractile and structural strength of smooth muscle cell layer around the arteries.
- Flexible and change with various pathologic processes associated with retinal blood flow.

**Some peculiarities of retinal vasculature**

- End arteries.
- Anastomosis between the retinal vessels &cilliary system of vessels exist near the lamina cribrosa with the vessels which enter the ON head from the circle of Zinn or Haler.
- Retinal Blood flow is 35-80μL/min.
- Retina gets 4% of the total blood supply to the eye (choroid 85%)
- Wall to lumen ratio of artery is about 1:5 & in vein 1:10.
- Retinal vessels are wider in adult than in child.
- Congenital aberrations in normally appearing eye-not pathological.
- E.g. cilioretinal arteries, derived from circle of Zinn & pass through temporal half of retina seen in about 20% of the eyes.



- Occasionally optociliary vein may be seen –a vessel arising from circle of Zinn emerges from the upper temporal border of the disc & sweeps round to join the lower nasal division of central retinal vein.
- Seen in conditions like ischaemic CRVO and Optic Nerve Sheath Meningioma.
- Differentiated from NVD by no leakage in FFA.

**REGULATION OF BLOOD FLOW**

Metabolic regulation of blood flow differs in retina and choroid. Retinal blood flow increases slightly in response to raised *pC02*, while hyperoxia causes slight vasoconstriction and reduced flow . Retinal flow is autoregulated, and is not

influenced by wide changes in perfusion pressures induced for instance by altering ocular pressure.

Choroidal blood flow is also increased by a raised *pC02,* but is not influenced by a raised *p02*.

Choroidal blood flow is not autoregulated. Changes in perfusion pressure cause a proportional change in blood flow, but because choroidal blood flow is normally greatly in excess of nutritional need, quite large changes in blood flow cause only minor changes in choroidal tissue fluid composition . There is some autoregulation of iris and ciliary body blood flow. Parva demonstrated a rise in blood flow in the choroid in response to bright light falling on the retina.

Neuroregulation of uveal flow is governed by a number of mechanisms. Sympathetic stimulation causes marked choroidal vasoconstriction and a fall in ocular pressure due to a fall in ocular blood volume. This is an alphaadrenergic response. The choroid is normally under a vasoconstrictor tone and it has been suggested that this may protect the retina and nerve head from overperfusion in certain circumstances such as arterial hypertension.

Vasomotor terminals end chiefly on arterioles and less on arteries. There is some innervation of veins and venules but none of the choriocapillaris.

The choroid responds to cholinergic stimulation by vasodilatation and it appears that parasympathetic cholinergic fibres synapsing in the ciliary ganglion supply the choroid via the short ciliary nerves.

The fenestrated capillaries of the choroid and ciliary processes are like those of the intestinal mucosa or kidney. Tracer studies with horseradish peroxidase demonstrate leakage of large molecules into the extravascular compartment. The movement of proteins such as albumin or IgG, or even smaller molecules, from the choroid across the retina is prevented by the tight junctions between retinal pigment epithelial cells.The extravascular albumin and IgG concentrations in the ciliary processes and choroid is in the region of 60-70% of that in the plasma, which creates a high osmotic pressure in the tissue fluid of the choroid, which exceeds that in the retina by about 15 mm of Hg.

This causes a net filtration of fluid from retina to choroid and is thought to be a force which 'sucks' the neuroretina onto the retinal pigment epithelium and balances forces tending to separate these layers and cause retinal detachment.

The choroidal capillary fenestrations may also be important in allowing the entry of vitamin A into the extravascular compartment for uptake by the retinal pigment epithelium.

The permeability to low molecular weight substances such as glucose is also high, i.e. more than twenty times greater than that in heart muscle and up to eighty times that in skeletal muscle. This contrasts with the situation in the retinal vessels, which are non-fenestrated. Here, glucose requires a transporter for delivery to the retinal tissues.

## CHOROIDAL CHANGES WITH AGEING

In the aged, the elastic tissue of the uvea degenerates and leads to a reduction in the elasticity of the tissues.

## PATHOPHYSIOLOGY OF DIABETIC RETINOPATHY AND IRIDOPATHY

**DIABETIC RETINOPATHY IS THE SINGLE MOST SIGNIFICANT OCULAR COMPLICATION OF DIABETES MELLITUS.**

**23 – 34% of patients of diabetes mellitus will have diabetic retinopathy**

**Pericytes**

- Morphological changes in early diabetes

- Cells become rounder,

- Less in number of processes,

- Apotosis of pericytes

- Loss of pericytes leads to

- Outpouching of capillaries,

- Microaneurysms,

- Breakdown of inner Blood Retinal Barrier.

- Retinal capillary endothelial death → ISCHEMIA

**Retinal Vascular Endothelial Cells**

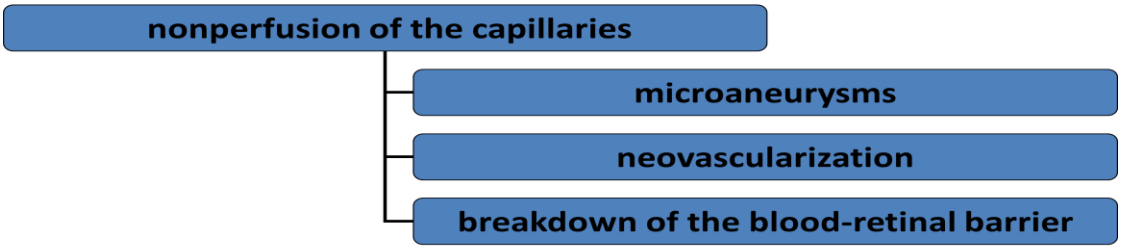
- Endothelial cell death is hallmark of diabetic retinopathy.
- Endothelial cell death precedes the formation of acellular capillaries.
- The resultant acellular capillaries lead to irreversible retinal ischemia.

**Retinal Vessel Leukostasis**

- Leukostasis within the retinal vasculature plays a crucial role in the endothelial cells death.
- Leukocyte adhesion to the diabetic retinal vessel wall causes apoptosis of pericytes and endothelial cells, vascular obstruction, subsequent non-perfusion, and release of cytokines that increase vascular permeability.

**VASOACTIVE FACTORS**

- Vasoactive factors (e.g., VEGF, protein kinase C, heparin, angiotensin II, PEDF, metalloproteases) and related biochemical pathways are affected by sustained hyperglycemia in diabetes.
- Structural and functional changes of retinal capillaries leads to development of DR.
- More important regarding development of Proliferative DR and Diabetic macular edema.




**Clinical features**

- Microaneurysms
- Intraretinal hemorrhages
- Hard exudates
- Cotton wool spots (soft exudates)
- Venous beading
- Intraretinal microvascular abnormalities (IRMAs)
- New vessels (NVD, NVE)

**Microaneurysms**

- Earliest clinically detectable lesion
- Loss of intramural pericytes & consequent weakening of vessel wall.
- 50-60 microns thick
- Young MA – dark red
- Old MA – yellow/white color due to hyalinization.
- FFA – bright hyper fluorescent dots.
- Life span – months to years

**Intraretinal hemorrhages**

- Source – MA, decompensated capillaries, IRMA
- Superficial – flame shaped, located in the Nerve fiber layer
- Deep – dot & blot pattern, located in the inner deeper layers
- FFA – blocked fluorescence

**Hard exudates**

- Break down lipid products of neuronal elements.
- Discrete yellow material
- Outer plexiform layer of the retina
- Circinate arrangement seen around leaking MA/capillaries
- Abnormal vascular leakage
- Removed by phagocytic action of macrophages

**Cotton wool spot**

- 'Soft exudate'
- Micro infarcts of Nerve Fibre Layer.
- Coagulative necrosis leading to stasis of axoplasmic flow.
- Fluffy white appearance, ill defined margins.
- Hyperfluorescent in FFA due to leakage and staining.

**Intraretinal microvascular abnormalities - IRMAs**

- Suspected new vessels within the retinal layers

- Could be dilated pre-existing capillaries
- Develop in areas of capillary non perfusion
- Act as shunt vessels
- Adjacent to cotton wool spots
- Bud from venous end
- Multiple IRMAs indicate a high risk of PDR (>50%)
- FFA - larger than normal capillaries
  - Usually do not leak dye
  - Donot cross any major vessel

**Venous changes**

- Venous beading, looping or sausage like segmentation
- Occurs in areas of focal retinal ischemia
- Suggestive of severe hypoxic state of the retina(40- 80% risk of PDR)
- FFA – seen adjacent to areas of Capillary Non perfusion.

**New vessels**

- Primitive mesenchymal element.
- Endothelial component – new vessel formation
- Fibrocyte component – fibroglial tissue growth
- Usually situated posterior to the equator
- Shape – fronds, stringy pattern, compact spherules etc

**NVD**

- New vessel on the disc or within 1 DD

- > $1/4^{th}$ of the retina nonperfused
- ↑ incidence of preretinal/vitreous hge
- FFA – early hyper fluorescence with profuse leakage in late phases

**NVE**

- NVE usually located along the major temporal arcades

**Extraretinal hemorrhage**

- Intragel
- Subhyaloid
- From NVD or NVE
- Contraction of fibrous elements leads to Tractional Retinal Detachment.

**ETDRS Revised modified Airlie House diabetic retinopathy classification**

| ETDRS level | ETDRS severity | ETDRS definition |
|---|---|---|
| 10 | No retinopathy | Diabetic retinopathy absent |

| ETDRS level | ETDRS severity | ETDRS definition |
|---|---|---|
| 20 | Very mild NPDR | Microaneurysms only |
| 35 | Mild NPDR | Hard exudates, cotton-wool spots, and/or mild retinal hemorrhages |
| 43 | Moderate NPDR | 43A:retinal hemorrhages moderate in 4 quadrant or severe in 1 quadrant<br>43B:mild IRMA in 1 to 3 quadrants |
| 47 | Moderate NPDR | 47A:both level 43 characteristics<br>47B:mild IRMA in 4 quadrants<br>47C:severe retinal hemorrhage in two to three quadrants<br>47D:venous beading in one quadrant" |
| 53A-D | Severe NPDR | 53A:≥2 level 47 characteristics<br>53B:severe retinal hemorrhages in 4<br>53C:moderate to severe IRMA in at least 1 |

| ETDRS level | ETDRS severity | ETDRS definition |
|---|---|---|
| | | quadrant<br>53D:venous beading in at least 2 quadrants" |
| 53E | Very severe NPDR | ≥2 level 53A-D characteristics |
| 61 | Mild PDR | NVE <0.5 disk area in 1 or more quadrants |
| 65 | Moderate PDR | 65A:NVE≥ 0.5 disk area in 1 or more quadrants<br>65B:NVD< 0.25-0.33 disk area |
| 71 and 75 | High-risk PDR | NVD ≥ 65B, or NVD < 65B or NVE ≥ 0.5 disk area plus VH or PRH, or VH or PRH obscuring ≥ 1 disk area |
| 81 and 85 | Advanced PDR | Fundus partially obscured by VH and either new vessels ungradable or retina detached at the center of the macula |

- NPDR: Non proliferative diabetic retinopathy, PDR: Proliferative diabetic retinopathy, IRMA: Intraretinal microvascular abnormalities, NVE: New vessels elsewhere, NVD: New vessels on or within 1 DP of the optic disk, PRH: Pre-retinal hemorrhage, VH:Vitreous hemorrhage.

**DI classified as follows (according to Abbreviated Modified Airlie House classification):**

**grade 0:** absence of DI (no DI) (Fig 9); fluorescein leakage is absent in late phases too;

**grade 1:** non-proliferative DI (NPDI), with dilated pupillary and stromal capillaries which let the dye leak through, giving rise to slight, short lasting fluorescence. Once the dye bolus has passed through, the hyperfluorescence tends to diminish and disappear, a diffuse veil remaining in the anterior chamber (Fig 10);

**grade 2**: proliferative DI (PDI), with new vessels at the pupillary margin and/or stroma, filling rapidly with dye and leaking equally promptly and diffusely (Fig 11);

**grade 3:** neovascular glaucoma (NVG), with newly formed fibrovascular tissue on the iris surface and at the iridocorneal angle, associated with intraocular hypertension.

Pupillary margin leakage was considered physiological in patients aged over 50 years(21)(26); therefore, eyes with age-related pupillary margin leakage only were classified in the group without DI (Fig 12).

Figures 9-12 were used as the standard angiograms against which all eyes were compared in order to minimise individual variations within each classification.

**DR classified as follows:**

**grade 0:** absence of DR (no DR), corresponding to level 1 of the abbreviated version of the Modified Airlie House classification(23);

**grade 1:** background DR (BDR), comprising levels 2, 3, and 4;

**grade 2:** pre-proliferative DR (PPDR), corresponding to level 5;

**grade 3:** proliferative DR (PDR), equivalent to level 6.

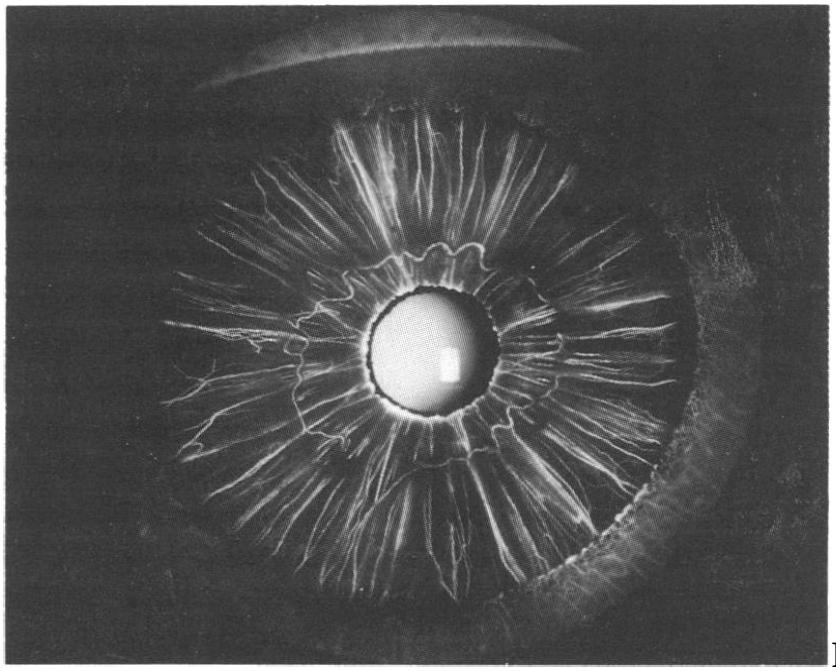


**FIGURE 9**

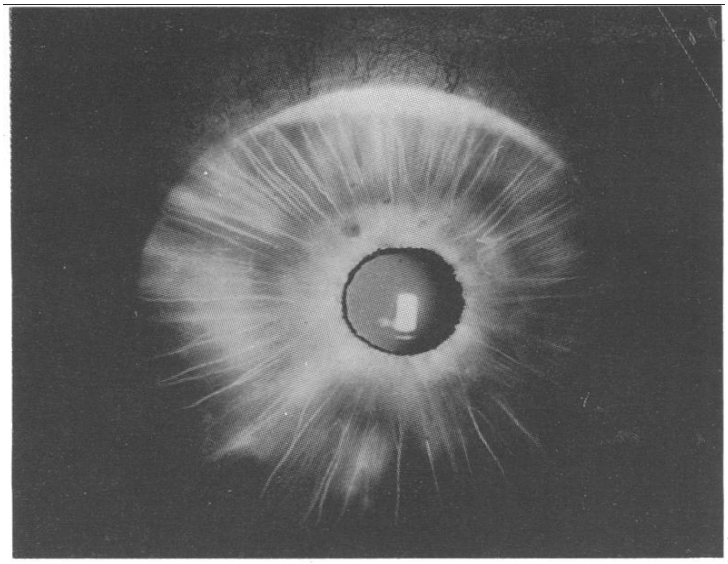


**FIGURE 10**

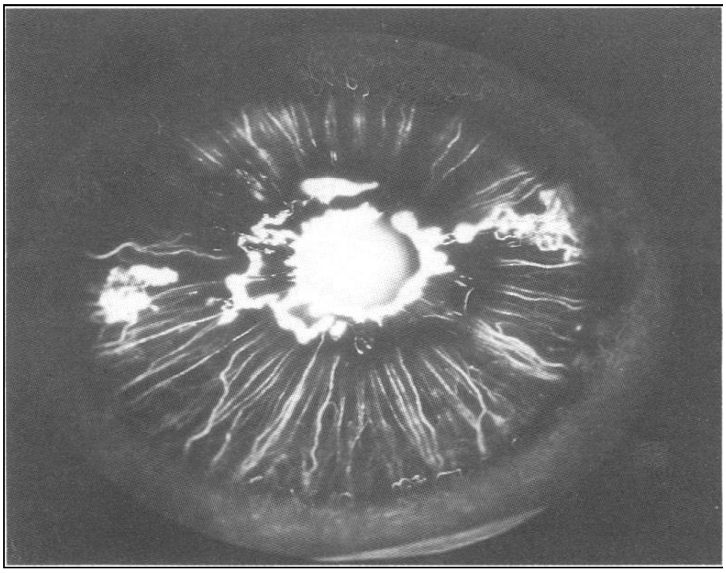


**FIGURE 11**

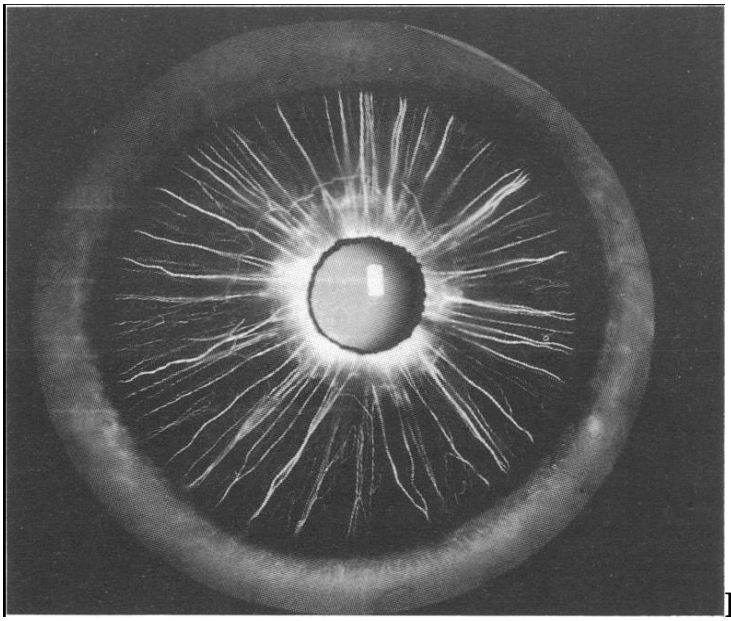


**FIGURE 12**

## Diabetic Iridopathy and Other Cases of Rubiosis Iridis

In an early diabetic iridopathy, some spots of dye leakage can be found around the pupillary margin [Fig.3]. The clinical appearance of new vessel formation is called "rubeosis iridis" [Fig.4]. Three different kinds of new vessel formation can be revealed by the iris angiogram.(13)

### *Loops*

The first kind of new vessel formation, small loops, arises mostly near the circulus arteriosus iridis minor. They are always permeable to fluorescein, due to the fenestrated structure of their walls. Figure 5 shows a case of chronic uveitis.

### *Sprouts*

The second form of neovascularization is the development of so-called sprouts, seen here in a case of severe iridocyclitis with acute secondary glaucoma figure 6. The angiographically characteristic feature of these sprouts is that they always arise around the pupillary margin, being later irregularly disseminated over the surface of the iris, and finally spreading into the chamber-angle, leading to a closed-angle glaucoma with the typical filling defects in the angiogram. The sprouts are as permeable to fluorescein as the loops.

***Bifurcations***

The third form of proliferation demonstrated by iris angiography comprises new vessels produced by an actual bifurcation of the original vessels, as in a case of a long-standing secondary closed-angle glaucoma [Fig.7]. Contrary to iridopathy in diabetics, in those caused by a central vein occlusion, the typical findings are massive dye leakage out of newly formed vessels around the pupillary margin as well as simultaneous diffuse fluorescence emanating from the radial normal iris vessels [Fig.8].

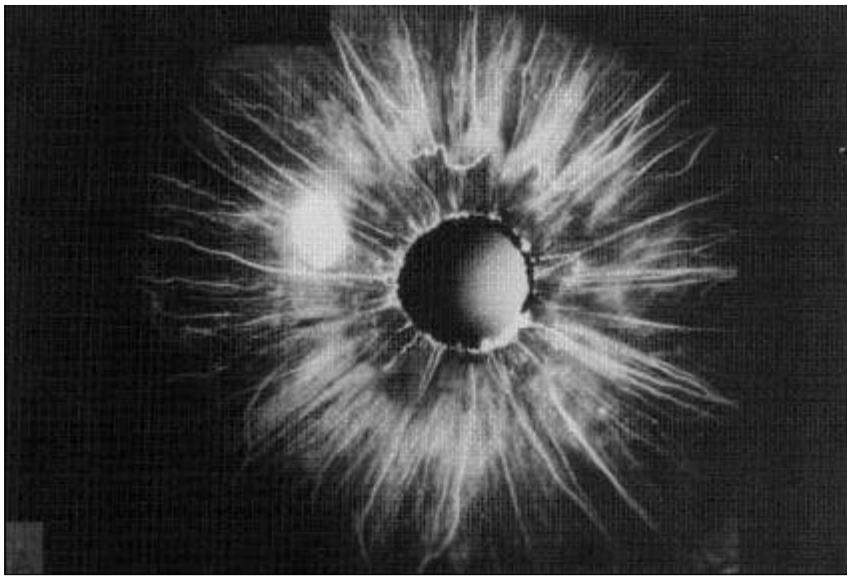


FIGURE 3

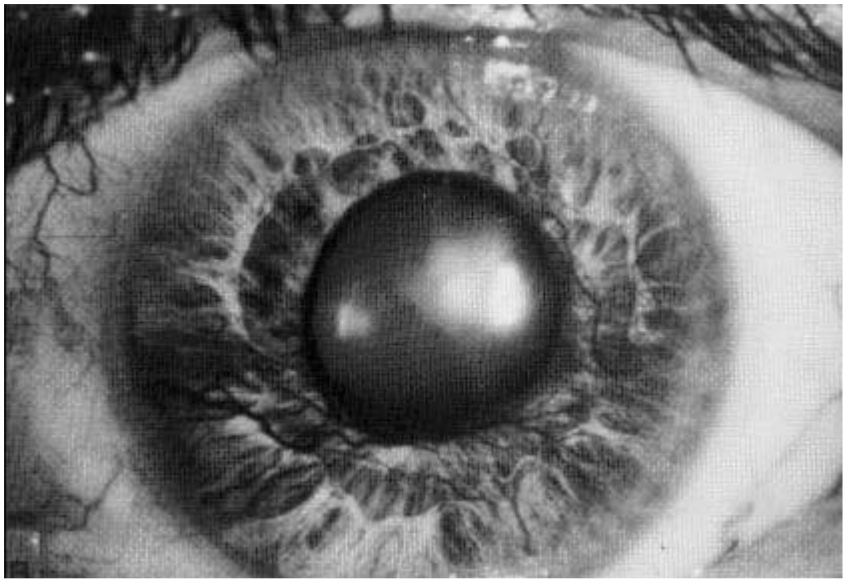


**FIGURE 4**

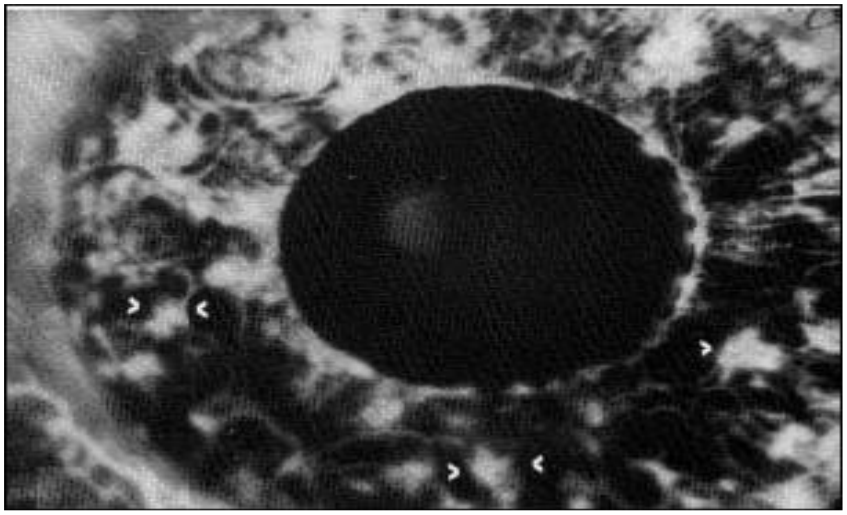


**FIGURE 5**

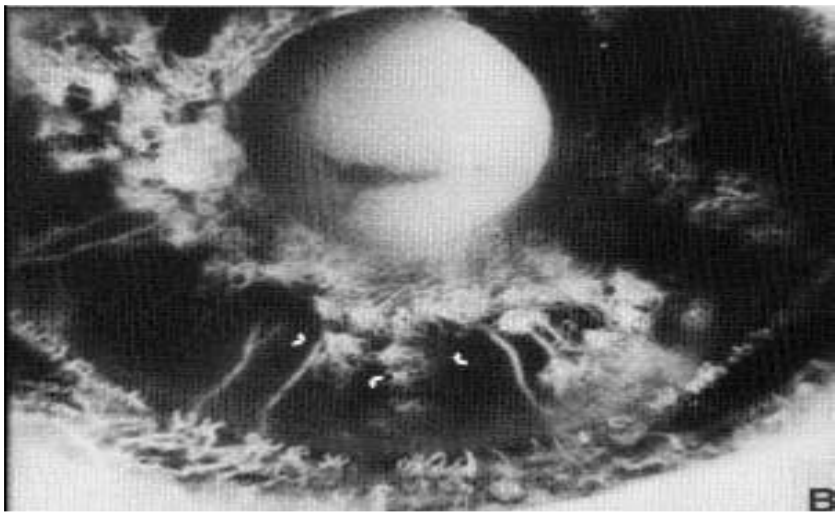


**FIGURE 6**

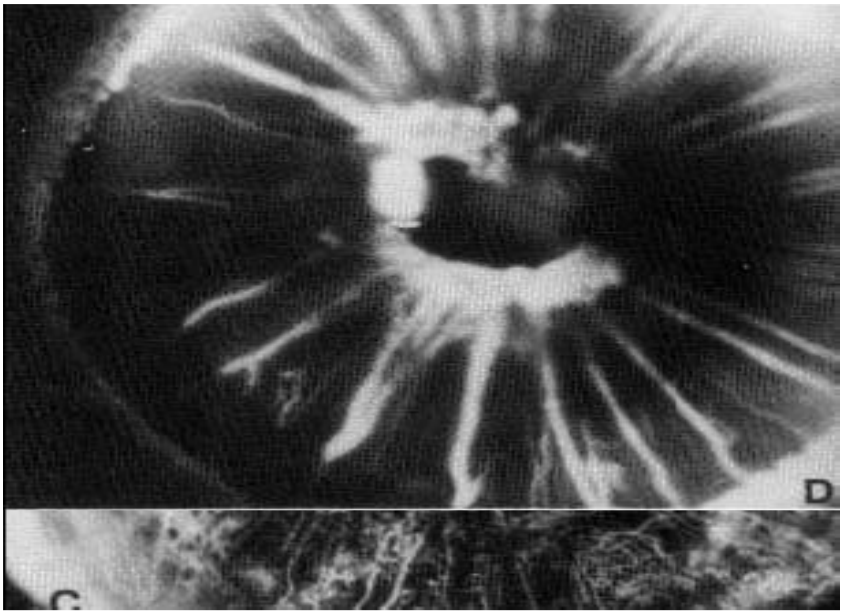



**FIGURE 7**

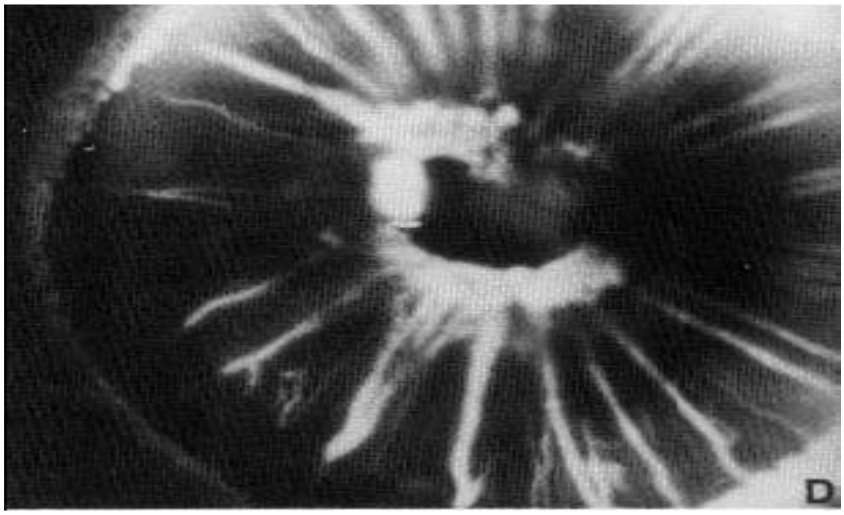



**FIGURE 8**

## FUNDUS AND IRIS FLUORESCEIN ANGIOGRAPHY (FFA AND IFA)

### WHAT IS IT?

This refers to photographing fluorescein dye in the retinal and iris vasculature following intravenous injection of fluorescein solution.

### WHAT IS FLUORESCEIN DYE?

Sodium Fluorescein - $C_{20}H_{10}Na_2O_5$ is a brown or orange red crystalline substance, alkaline in nature. It was first synthesised in 1871 in Germany by VonBayer.

Fluorescein absorbs blue light (490 nm) and emits yellow green light (530 nm). It is metabolised by liver and excreted by kidneys.

### WHAT ARE THE INDICATIONS OF FFA?

1.Diabetic retinopathy- severe NPDR with CSME, PDR

2.Vascular occlusions,

3.Eales' disease,

4.Central serous retinopathy,

5.Cystoid macular edema,

6.Neovascular glaucoma

7.Choroidal neovascularization

8.RPE dysfunction & detachment

**INDICATIONS FOR IFA:**

1. Tumors and cysts of the iris,

2.Degenerative diseases,

3.New vessel formation of the iris in patients suffering from diabetes mellitus or retinal vascular occlusion,

4.Abnormal vascular formations and

5.An angioma of the iris.

**WHAT ARE THE CLINICAL USES OF FLUORESCEIN DYE?**

1. Research

2. Care

Treatment protocol for retinal diseases to understand retinal and choroidal lesions . Eg. ARMD, Diabetic retinopathy, Retinal detachment.

**WHAT ARE THE GENERAL PRINCIPLES OF FLUORESCEIN ANGIOGRAPHY?**

1. Fluorescein is 85% bound to serum protein.

2. 15% unbound "free fluorescein"

3. Inner blood retinal barrier retinal capillaries and outer blood retinal barrrier are impermeable to fluorescein.

4. Choriocapillaries only to free fluorescein.

## WHAT ARE THE COMPLICATIONS OR HAZARDS OF FFA?

1.Extravasation of dye –thrombophlebitis

2.Discoloration of skin & urine

3.Transient nausea

4.Vomiting, pruritis, urticaria,

5.Bronchospasm, laryngeal edema,

6.Anaphylaxis, hypotension, syncope

7.Seizures, myocardial infarction, cardiac arrest

## WHAT ARE THE CONTRAINDICATIONS FOR FFA?

Pregnancy, lactating mothers, Chronic kidney disease, previous hypersensitivity to fluorescein.

## HOW IS THE PROCEDURE DONE?

1. The procedure is explained to the patient and informed consent is obtained.

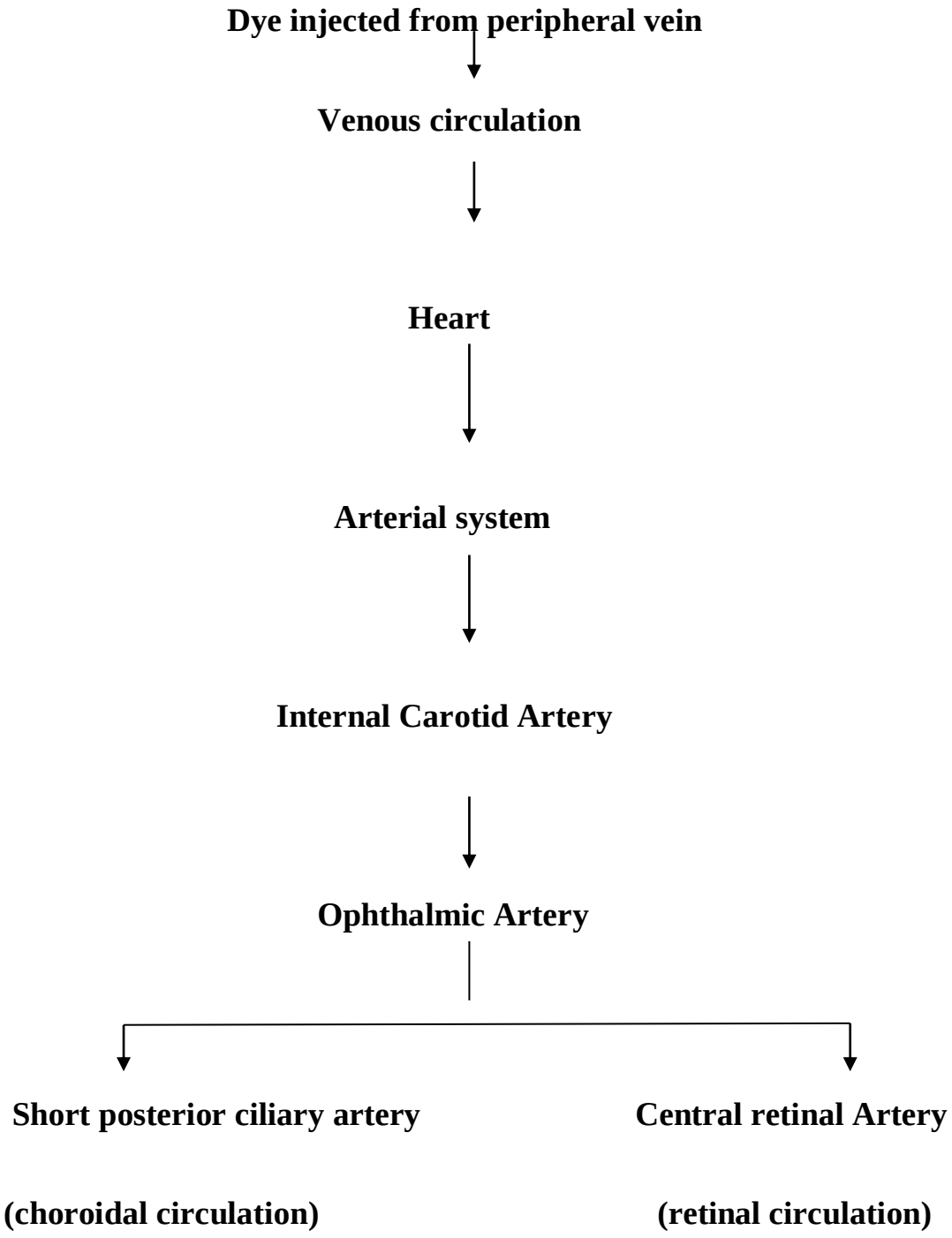
2.Pupils should be well dilated.

3.Patient is seated in front of the camera and colour photograph and red free photograph are taken.

4. Dye is injected in the forearm or antecubital vein.

5.IV cannula is inserted, 5ml of 10% fluorescein or 3 ml of 20% fluorescein solutions is taken and injected over 5-10 sec.

**CIRCULATION OF NaF?**



## WHAT ARE THE PHASES OF A NORMAL FLUORESCEIN ANGIOGRAPHY?

### 1. CHOROIDAL PHASE (PRE ARTERIAL PHASE)

Occurs 9-15 seconds after dye injection. Choroidal filling via the short posterior ciliary arteries results in initial patchy filling of lobules followed by a diffuse blush (as the dye leaks out of the choroidal capillaries). cilioretinal vessels and prelaminar optic disc capillaries fill during this phase due to leakage of free fluorescein from the non-fenestrated choriocapillaries.

### 2. ARTERIAL PHASE

The arterial phase starts about a second after the onset of choroidal fluorescence and shows retinal arteriolar filling and the continuation of choroidal filling.

### 3. THE AV/CAPILLARY PHASE

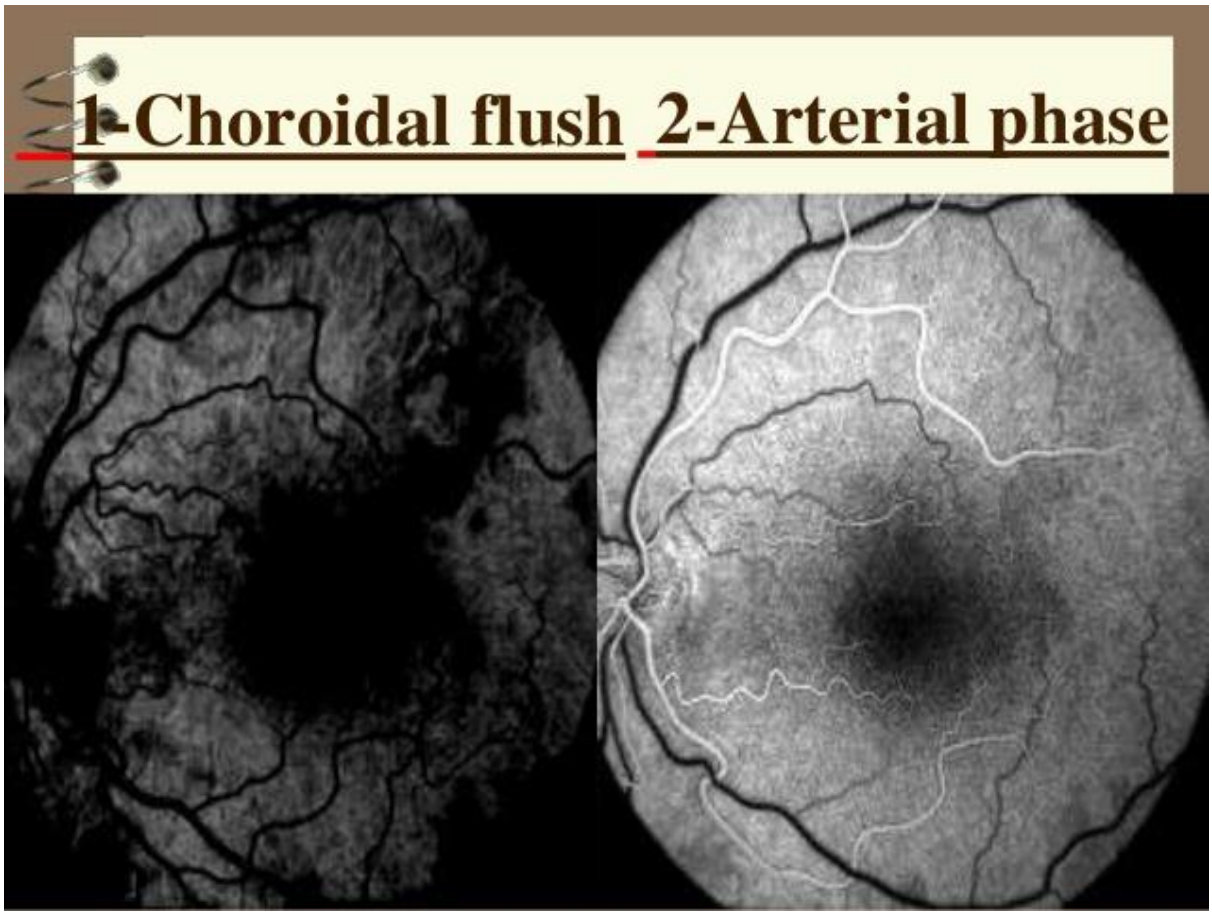
Shows complete filling of the arteries and capillaries with early laminar flow in the veins in which the dye appears to line the venous wall leaving an area of hypofluorescent strip. The peri-foveal capillary perfusion is particularly prominent as the underlying choroidal vasculature is masked by the luteal pigment in the retina and melanin pigment in the RPE. At the centre of the capillary ring is the foval avascular zone 500 micrometer in diameter.

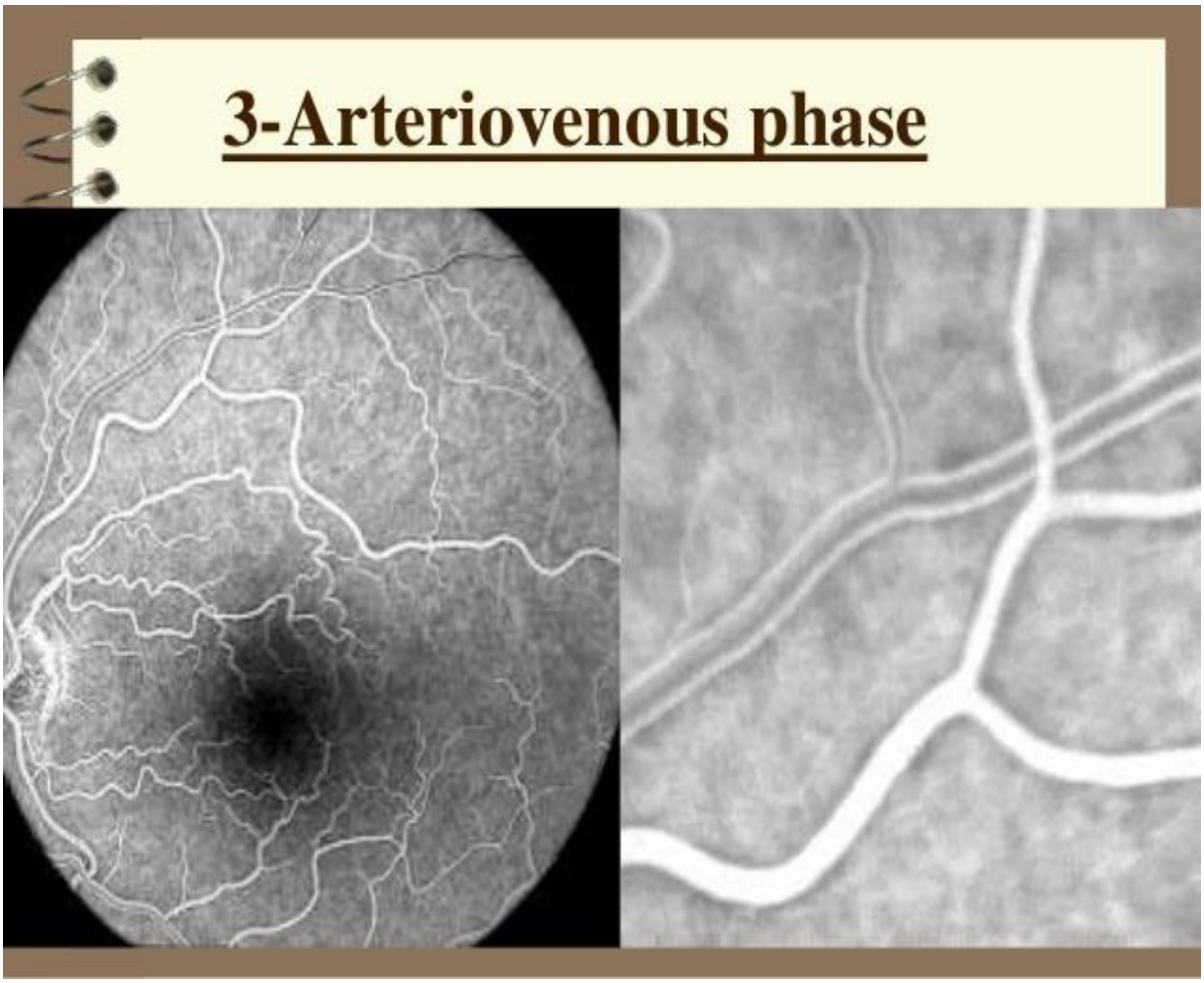
## 4. VENOUS PHASE

Early filling of the veins is from the tributaries forming their margins, resulting in tramline effect. Later the whole diameter of the vein is filled. maximal perifoveal capillary filling is reached in 20-25 sec.

## 5. THE LATE RECIRCULATION PHASE

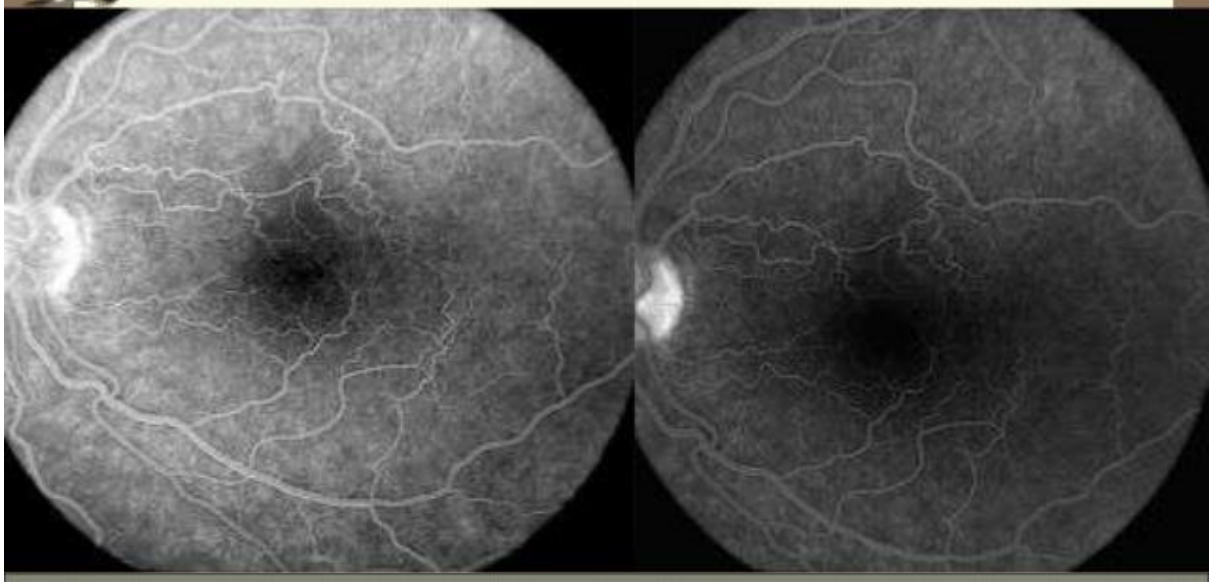
The first phase of fluorescein circulation is generally completed by appox. 30 sec. This phase demonstrates the effective concentration, recirculation , dilution and elimination of the dye. After 10-15 min little dye remains in the blood circulation. Blood which has left the ocular structures is now visible.

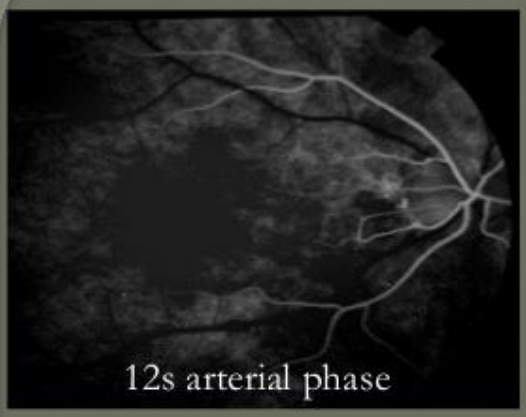


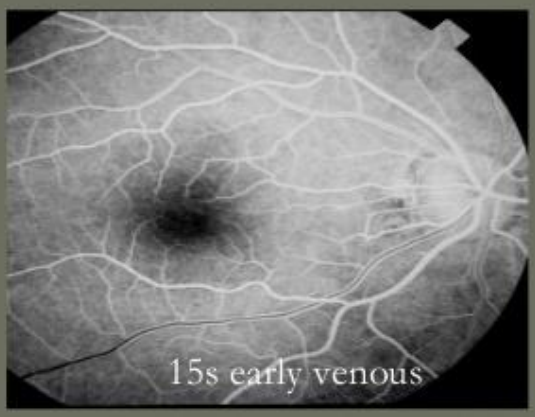

3-Arteriovenous phase

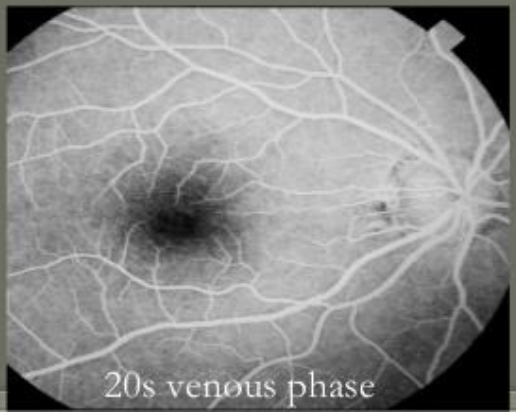
# 4-Venous phase

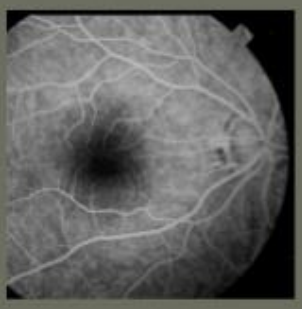
**Mid Phase** **Late**





## WHAT ARE THE CAUSES FOR HYPO AND HYPERFLUORESCENCE?

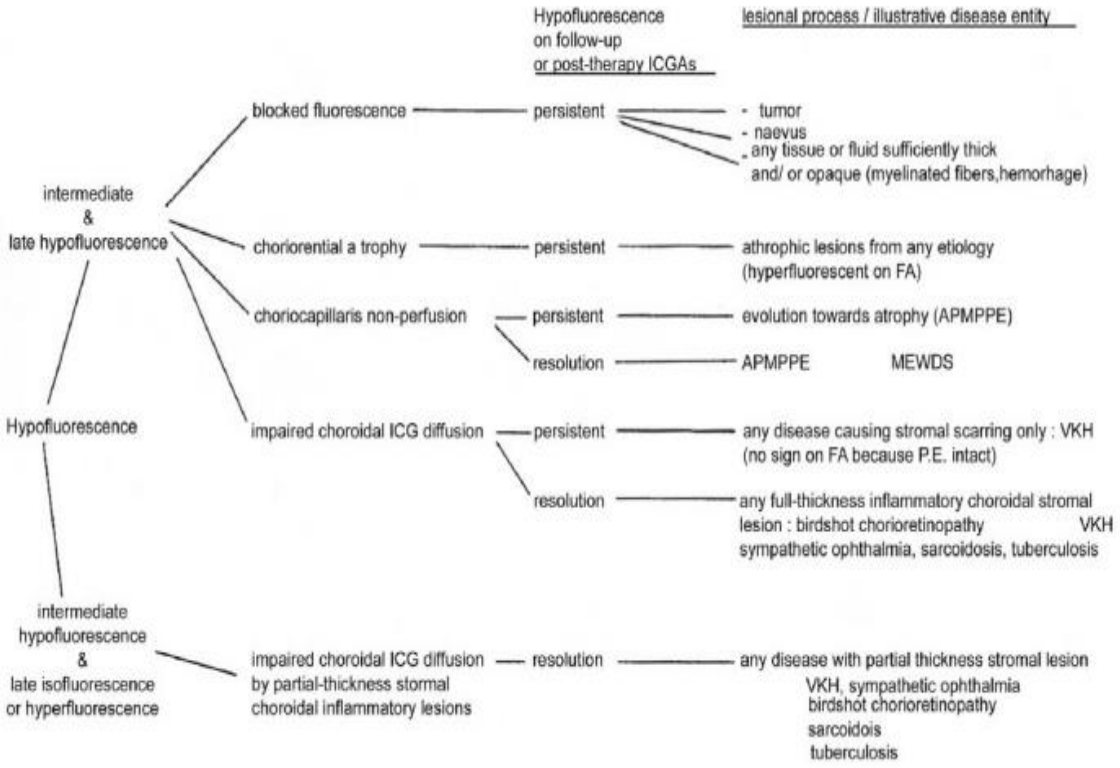



Figure 11: (a) Schematic interpretation of indocyanine green angiography hypo fluorescence

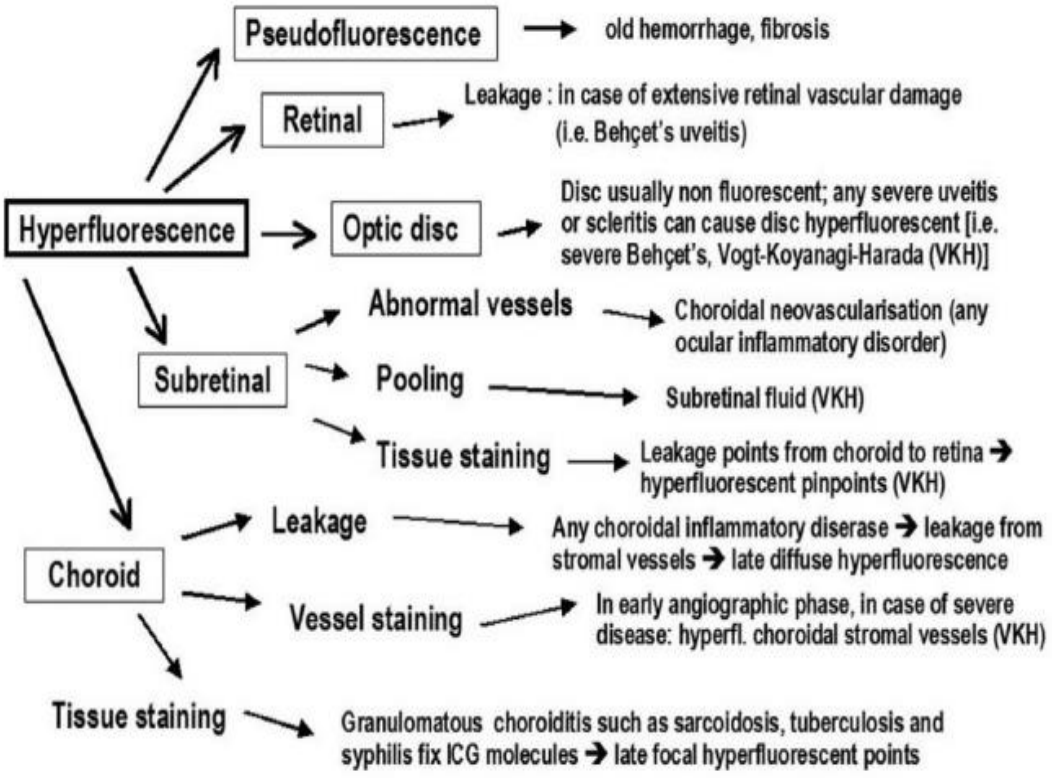



Figure 11: (b) Schematic interpretation of indocyanine green angiography hypo fluorescence; (2b) Schematic interpretation of indocyanine green angiography hyperfluorescence

## NORMAL PHASES OF IRIS FLUORESCEIN ANGIOGRAPHY

Figure 1 shows a normal iris angiogram with the beginning arterial, full and late venous angiographical phases. In the normal iris angiogram, the peripheral arteries begin to stain approximately 14-16 sec after injection and, 2-3 sec later, fluorescein appears at the pupillary margin. After a further 3-4 sec, venous filling occurs. The arteries, which appear of larger diameter than the veins in the angiogram, originate at the circulus arteriosus iridis major, follow a relatively straight radial course, mostly in pairs, within the superficial stroma, and reach the pupillary margin where they then divide to form a dense capillary network. The veins, which are more numerous and narrow than the arteries, are situated in the deeper stroma and traverse back to the iris periphery to join the vortex veins.

Figure 2 demonstrates a well-developed circulus arteriosus iridis minor, which is rarely so visible.

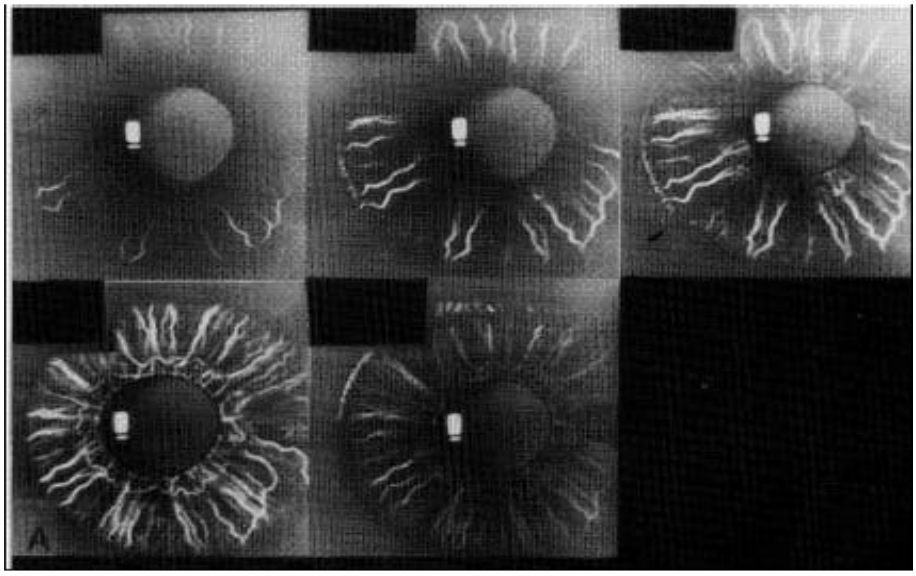


**FIGURE 1**

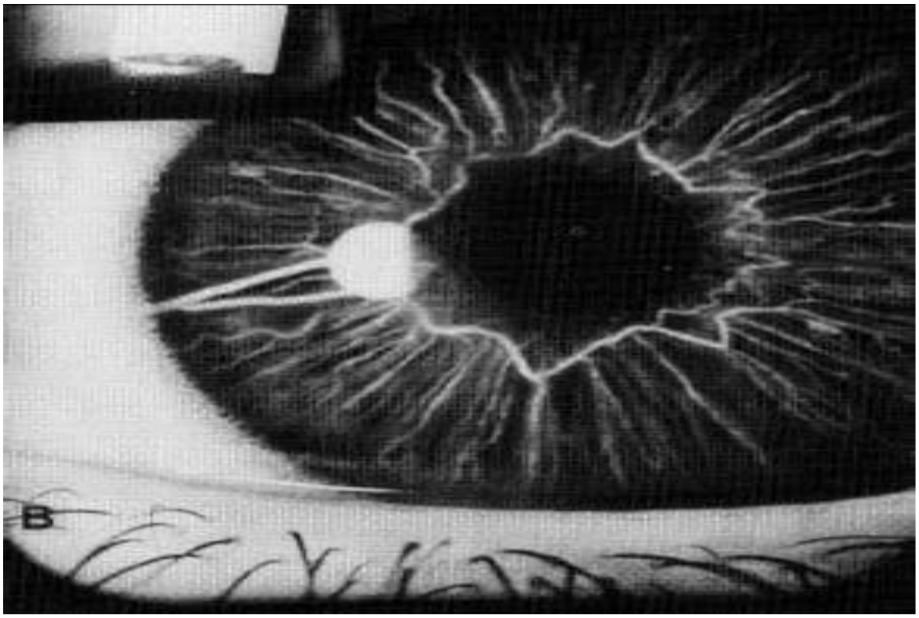



**FIGURE 2**

# REVIEW OF LITERATURE

## Relation between iridopathy and retinopathy in diabetes

*Francesco Bandello, Rosario Brancato, Rosangela Lattanzio, Marcello Galdini, Bruno Falcomata*

**Abstract**

In order to assess the relation between diabetic iridopathy (DI) and retinopathy (DR), 225 eyes of 117 diabetics with clear media were evaluated. Each patient underwent iris and retinal fluorescein angiography, which was used to classify DI and DR. DI was classified as:
absence of DI; non-proliferative DI; proliferative DI; neovascular glaucoma. DR was classified as: absence of DR; background DR; pre-proliferative DR; proliferative DR. The sensitivity of iris fluorescein angiography in assessing DR was 44 5%, the specificity 88%, the positive predictive value 92i8%, and the negative value 31'2%. In pre-proliferative and proliferative DR, fluoroiridographic detection of iris neovessels gave a sensitivity of 56% and a specificity of 100%. The positive predictive value was 100% and the negative value 65%. In conclusion, iris fluorescein angiography yields valuable information on DR and is a helpful basis for avoiding complications when scheduling eyes with dioptric media opacities or surgery.

**(BrJ7 Ophthalmol 1994; 78: 542-545)**

## Editorial: Fluorescein angiography of the iris

Iris angiography is likely to be of considerable value in the early detection of neovascularisation and will continue to provide one method for the experimental investigation of anti-inflammatory therapy in the laboratory and in clinical trials.

In this issue of the BJO 3 papers concern iris angiography, where the uses for the technique are amplified. Dr Laatikainen has followed the iris vascular changes in patients with diabetic retinopathy, and as a result has been able to classify precisely the lesions which she has found, providing a system of grading which will be valuable in future studies of possible treatment modalities. In a second contribution she describes the iris vascular response in a group of patients with uveitis. A third paper, by Drs Brovkina and Chichua, concerns the value of angiography in the diagnosis of iris tumours from which histological material was obtained. These 3 papers are an important addition to an expanding field, which has recently been expertly reviewed in a monograph on iris angiography by Kottow (1978).

**(British Journal of Ophthalmology, 1979, 63, 143-144)**

# Iris Angiography of the Anterior Segment

*Ulrich Demeler, Franz Diekstall, and Wilhelm Kröncke*

*Augenklinik, Zentralkrankenhaus St.-Jurgen- Strasse, Bremen, Federal Republic of Germany*

**Summary**

Iris angiography is an important method for examination of disorders of the iris and anterior chamber. Fluorescein angiography reveals information about the type, and thereby about the probable malignancy of iris tumors. In cases of iris cysts, angiography allows the differential diagnosis between congenital cysts and epithelial downgrowth cysts, in which a surgical treatment for the latter is absolutely necessary. Further indications for fluorescein angiography of the iris are neovascularization of the iris (so-called, rubeosis iridis), degenerative diseases, and anomalies of iris vessel formation. In these cases fluorescein angiography permits the diagnosis or differential diagnosis as well as follow-up.

**(Journal of Ophthalmic Photography Vol. 9, No. 2 December 1986)**

## Cine photography and video recording of anterior segment fluorescein angiography

*R. J. MARSH AND S. M. FORD*

*From the Western Ophthalmic Hospital, London*

SUMMARY A description is given of apparatus and technique for carrying out cine photography and video recording of anterior segment fluorescein angiography. We found cine best for single frame analysis and video tape recording less expensive.

**(British Journal of Ophthalmology, 1978, 62, 657-659)**

## Fluorescence angiography of the iris

*A. CRAANDIJK AND A. L. AAN de KERK*

*Department of Ophthalmology, Rotterdam Eye Hospital, Medical Faculty of Rotterdam, TheNetherlands*

### Discussion

The advantages of this technique are twofold, provided that the photographic department is equipped with a fundus camera that has been modified for fluorescence angiography.

(i) No photo slit lamp is needed.

(2) The luminar lens is designed to photograph a flat surface, unlike the fundus camera

which is specially corrected for a hollow plane such as the fundus, so that photography of a convex structure such as the outer eye results in distortion which is further augmented by the use of a 20 cm. lens in front of the objective. Furthermore, in the technique described, high-speed film is not necessary, and the film used does not have to be force developed; this means that the enlargements show very little graining.

Last, but not least, the attachment of the motorized Nikon camera, including the extension ring set and the Luminar lens, is much less expensive than an extra flash unit and photo slit lamp.

**Summary**

An iris fluoro-angiographic technique is described, using a Zeiss fundus camera to supply the blue excitation light. The fluorescence is photographed on an external motorized Nikon camera.

A fluoro-angiogram from a normal subject is compared with one from a patient with a naevus iridis.

## PART II

**TITLE: " A CROSS-SECTIONAL STUDY TO DETERMINE THE ROLE OF IRIS FLUORESCEIN ANGIOGRAPHY IN CHRONIC DIABETIC PATIENTS BEFORE CATARACT SURGERY "**

**AIMS AND OBJECTIVES:**

1)To determine the role of iris fluorescein angiogram in detecting iris vessel abnormalities in diabetic patients.

2)To compare the fluoroscopic changes seen in iris with stage of diabetic retinopathy in diabetic patients with mature cataract.

**STUDY DESIGN:** Non randomized, Prevalence / cross-sectional study

**SAMPLE SIZE:** 50 patients

**MATERIALS AND METHODS:**

Patients were recruited from among all those who visited our outpatient department as well as inpatients of the ophthalmology ward of GRH , Madurai between March 2017 and August 2017.

**STUDY PERIOD:** 6 months (March 2017 to August 2017).

**SELECTION OF SUBJECTS:**

A total of about 50 diabetic patients attending our eye department OPD and residing as inpatients in the ophthalmology ward of GRH,Madurai satisfying the following inclusion and exclusion criteria were considered for the study.

**The inclusion criteria:**

1.Diabetes mellitus type I or type II with U/L or B/L mature cataract of all types.

2.Normal renal functions with no other contraindications for fluorescein angiography

**The exclusion criteria:**

1.Structural abnormalities of retina or vitreous detected by B-scan.

2.Patients on topical medications like anti-glaucoma drugs, NSAIDs, anti-allergics,miotics.

3.Patient who had already underwent any type of intraocular surgery /laser photocoagulation for retina, ciliary body or iris;

4.Absence of any other comorbidities that can cause iris angiographic changes namely iris tumours, vaso-occlusive retinal diseases, angle closure glaucoma, chronic iridocyclitis /uveitis, essential progressive iris atrophy, persistent pupillary membrane, tuberculosis or angioma of iris.

5.Patients with frank iridopathy obviously visible on oblique or routine slit lamp examination.

6.All other types of diabetes like gestational diabetes, MODY etc.

7.Patients with absolute contraindications for fluorescein angiography- pregnancy and allergy to the dye.

8.All patients who were found to have associated other retinal vascular abnormalities post operatively which could have lead to the iris vasculature changes.

**FINANCIAL SUPPORT:** Nil

**METHODOLOGY:**

All subjects were selected only after they provided informed consent for entry to the trial.

All patients underwent a complete ocular examination (which includes Best corrected visual acuity, slit lamp examination, tonometry by Goldmann applanation tonometer, ophthalmoscopy of the other eye if possible, Ascan biometry , B-scan ultrasonography).

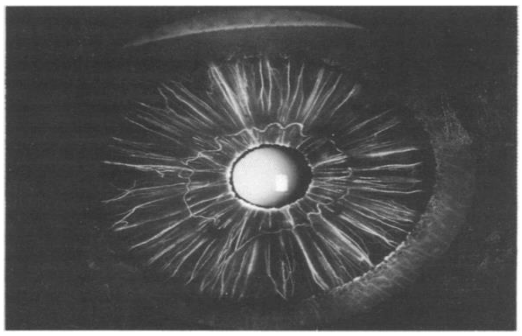
Iris fluorescein angiography was performed using a standard model zeiss fundus camera with a dual filter system (excitation filter and barrier filter) with the parameters adjusted for photographing the anterior segment of the eye.

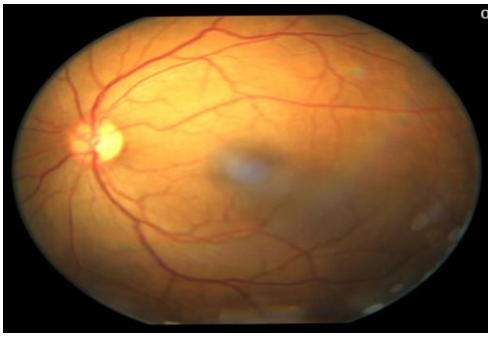
At the start of the examination, fluorescein was injected intravenously (as in retinal angiography). A 5 ml dose of a 20% solution of fluorescein was used (about 14 mg/kg body weight); care was taken that pupils were not dilated with mydriatics nor contracted with miotics.

Then, after the cataract surgery but within 2 weeks from the date of iris fluorescein angiography, retinal fluorescein angiography was performed. A standard model zeiss fundus camera with dual filter system (excitation and barrier filter) was used with imaging parameters suitable for Fundus colour photography and fundus fluorescein angiography. Fundus photographs were graded according to the Modified Airlie House classification.(23) Blind retinal and iris angiogram evaluations were carried out separately. Each eye was then classified according to the degree of DI and DR found. Retinal angiograms were employed in selected cases in DR classification to confirm the gradings assessed by colour fundus photographs. The iris and retinal photographs were then matched with those found in Figure 1.

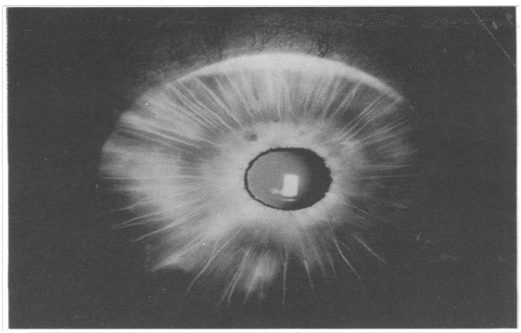
TABLE 1: MODIFIED AIRLIE HOUSE CLASSIFICATION OF DIABETIC RETINOPATHY AND IRIDOPATHY

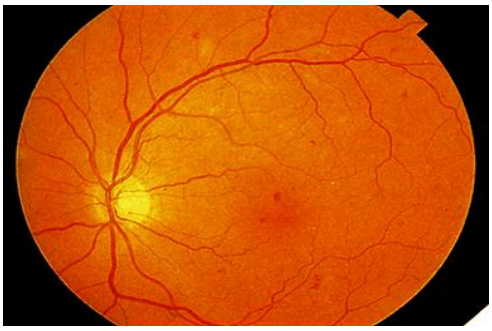
| DIABETIC RETINOPATHY | MODIDIED AIRLIE HOUSE CLASSIFICATION | DIABETIC IRIDOPATHY |
|---|---|---|
| Absence of DR (no DR), corresponding to level 1 of the ETDRS classification (corresponding to no Diabetic Retinopathy) | GRADE 0 | Absence of DI (no DI); fluorescein leakage is absent in late phases too; Pupillary margin leakage was considered physiological in patients aged over 50 years; therefore, eyes with age-related pupillary margin leakage only were classified in the group without DI |
| Background DR (BDR), comprising levels 2, 3, and 4 of ETDRS classification (corresponding to background, mild and moderate NPDR) | GRADE 1 | Non-proliferative DI (NPDI), with dilated pupillary and stromal capillaries which let the dye leak through, giving rise to slight, short lasting fluorescence. Once the dye bolus has passed through, the hyperfluorescence tends to diminish and disappear, a diffuse veil remaining in the anterior chamber |
| Pre-proliferative DR (PPDR), corresponding to level 5 of (corresponding to Severe and pre proliferative diabetic retinopathy) | GRADE 2 | Proliferative DI (PDI), with new vessels at the pupillary margin and/or stroma, filling rapidly with dye and leaking equally promptly and diffusely |
| Proliferative DR (PDR), equivalent to level 6 (Corresponding to proliferative diabetic retinopathy of all types) | GRADE 3 | Neovascular glaucoma (NVG), with newly formed fibrovascular tissue on the iris surface and at the iridocorneal angle, associated with intraocular hypertension. |



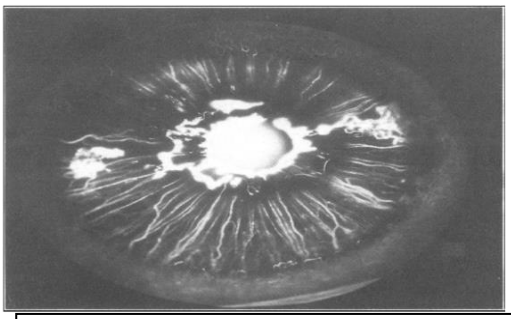


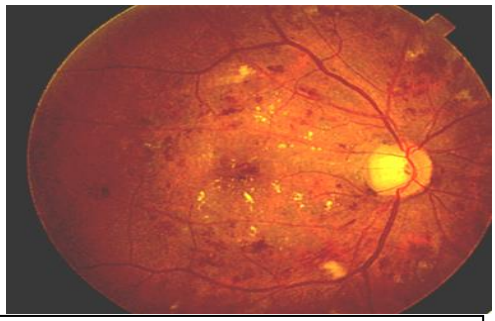
| GRADE 0 DI | GRADE 0 DR |
|---|---|



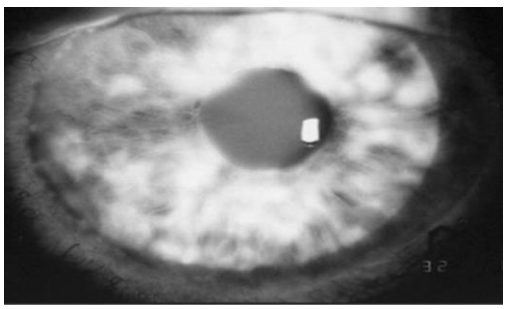


| GRADE 1 DI | GRADE 1 DR |
|---|---|





| GRADE 2 DI | GRADE 2 DR |
|---|---|



| GRADE 3 DI | GRADE 3 DR |
|---|---|

FIG 1:The above standard angiograms and fundus photographs illutrate the various grades of Diabetic Iridopathy and Diabetic Retinopathy respectively ,which were used as standards to compare our subjects for classification of DI and DR.

Thus to ascertain whether fluoroiridographic detection of DI is useful as an indirect assessment of DR, we considered:

* patients without DI and without DR as true negative;

* patients with DI and DR as true positive;

* patients without DI but with DR in any form as false negative;

* patients with DI in any form but with no fluoroangiographic retinal lesions as false positive.

**STATISTICAL ANALYSIS:**

Data analysis was done with the help of computer by using Graphpad prism 7 software. Using this software mean , confidence interval and ‘p’ value were calculated through, the Fisher's exact test , pearson correlation and p value of $<0.05$ was taken as significant.

## OBSERVATION AND ANALYSIS

### TABLE 1: AGE DISTRIBUTION OF THE STUDY POPULATION

| S.NO | AGE GROUP (IN YEARS) | TOTAL NO. OF PATIENTS | PERCENTAGE |
|---|---|---|---|
| 1 | 31-40 | 2 | 4.00% |
| 2 | 41-50 | 4 | 8.00% |
| 3 | 51-60 | 22 | 44.00% |
| 4 | 61-70 | 20 | 40.00% |
| 5 | 71-80 | 2 | 4.00% |
| 6 | TOTAL | 50 | 100% |

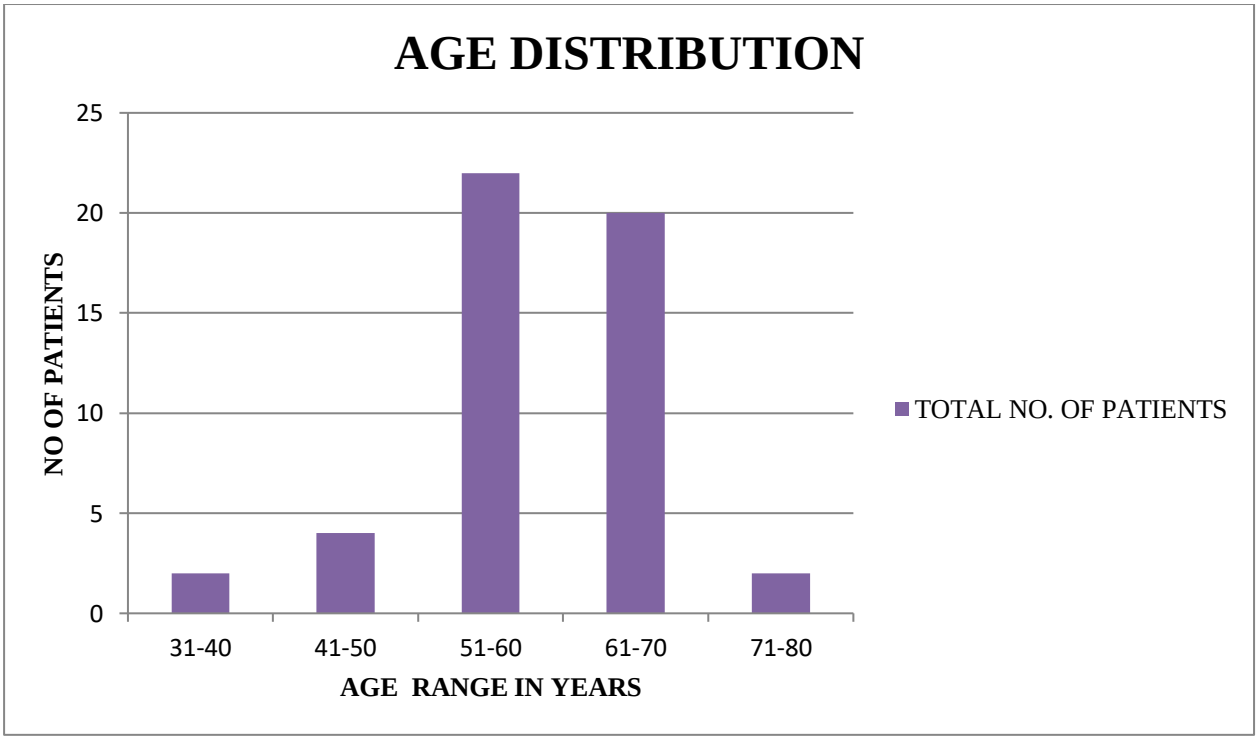



TABLE 1 and GRAPH show that in our study the age distribution of patients was within 30-80 years with majority falling between 51-70 years with the mean age of 60.64 years ,median and mode being 60 years.

**TABLE 2: SEX DISTRIBUTION OF THE STUDY POPULATION**

| S.NO | SEX | NO. OF PATIENTS | PERCENTAGE |
|---|---|---|---|
| 1 | MALE | 22 | 44% |
| 2 | FEMALE | 28 | 56% |
| 3 | TOTAL | 50 | 100% |

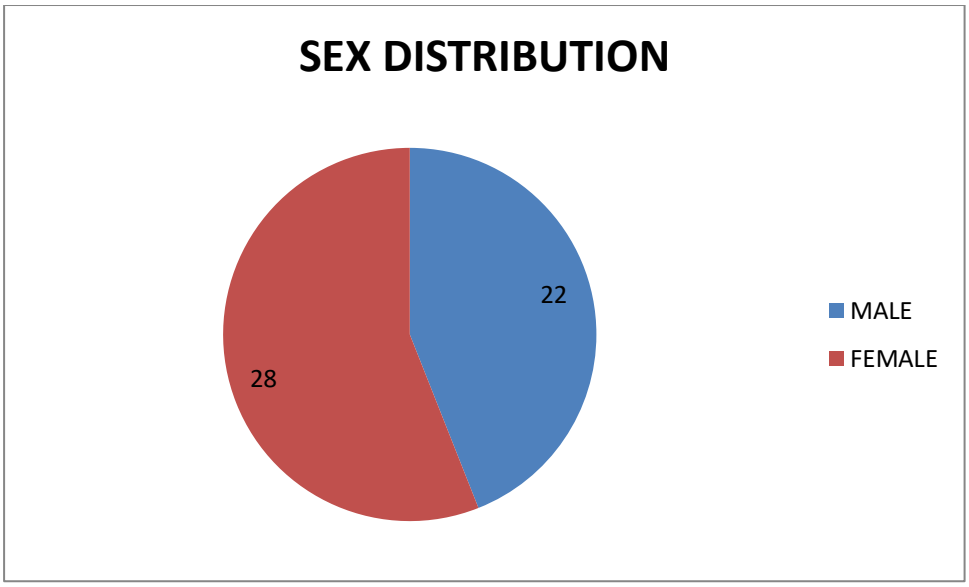



TABLE 2 and GRAPH show that out of the 140 patients under study, 28 (56%) were females and 22 (44%) were males.

## TABLE 3: DISTRIBUTION OF TYPE OF DIABETES

| S.NO | TYPE OF DIABETES | NO OF PERSONS | PERCENTAGE |
|---|---|---|---|
| 1 | TYPE 1 | 4 | 8% |
| 2 | TYPE 2 | 46 | 92% |
| 3 | TOTAL | 50 | 100% |

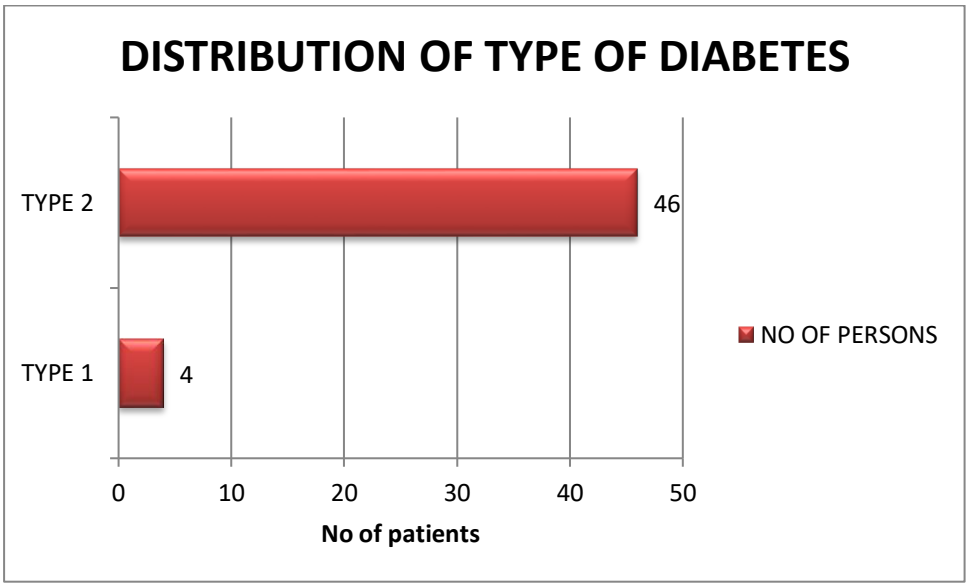



TABLE 3 and GRAPH reveal that there were 4 patients (8%) diagnosed to have chronic Type 1 Diabetes mellitus and the remaining 46(92%) patients with Type 2 Diabetes mellitus forming the major proportion of our patients as expected.

**TABLE 4: DISTRIBUTION OF SEVERITY OF DIABETIC RETINOPATHY**

| S.NO. | GRADE | NO OF PATIENTS | PERCENTAGE |
|---|---|---|---|
| 1 | GRADE 0 | 18 | 36% |
| 2 | GRADE 1 | 14 | 28% |
| 3 | GRADE 2 | 13 | 26% |
| 4 | GRADE 3 | 5 | 10% |
| 5 | TOTAL | 50 | 100% |

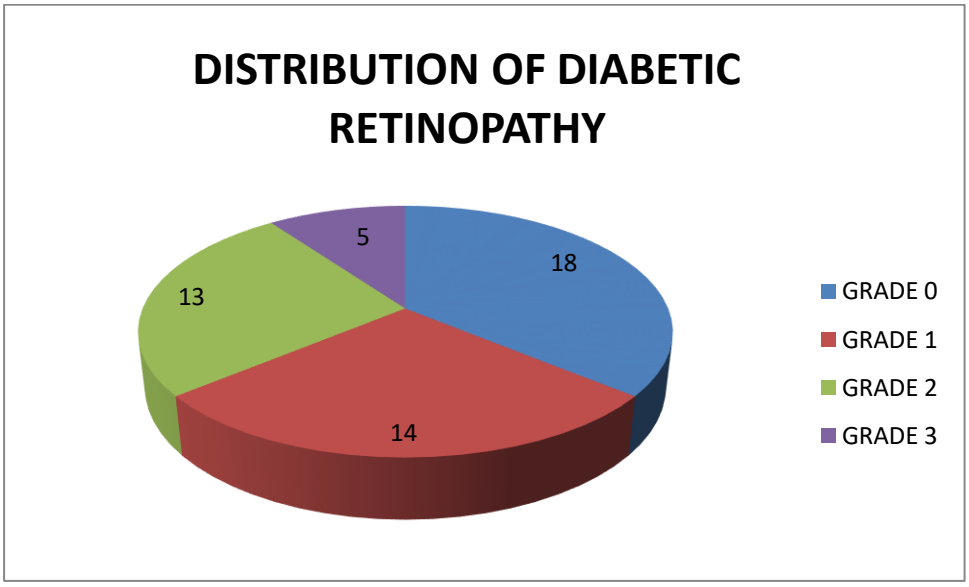



TABLE 4 and graph show the distribution of severity of diabetic retinopathy in our patients. 18 (36%) had No DR /Grade 0 DR (according to modified airlie House classification). 14 (28%) had grade 1 DR, 13(26%) had grade 2 DR while 5 (10%) had grade 3 DR.

**TABLE 5: DISTRIBUTION OF DIABETIC IRIDOPATHY**

| S.NO. | GRADE | NO OF PATIENTS | PERCENTAGE |
|---|---|---|---|
| 1 | GRADE 0 | 35 | 70% |
| 2 | GRADE 1 | 12 | 24% |
| 3 | GRADE 2 | 3 | 6% |
| 4 | GRADE 3 | 0 | 0% |
| 5 | TOTAL | 50 | 100% |

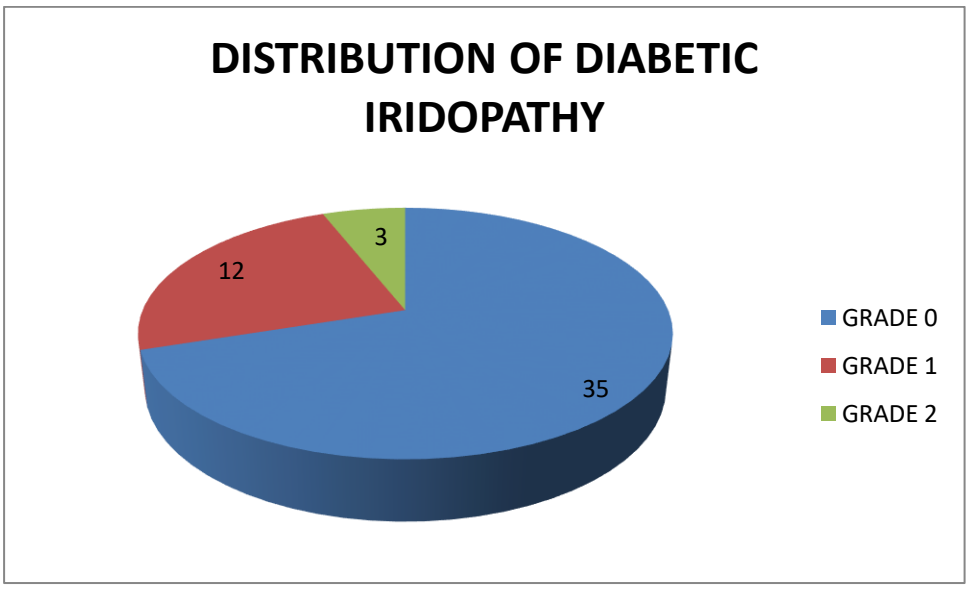



TABLE 5 and the corresponding graph show the distribution of Diabetic Iridopathy in our study population. Majority had no significant diabetic changes in their iris (i.e.35 patients {70%}). 12(24%) had grade 1 and 3 (6%) had grade 2 iridopathy changes and no subjects showed grade 3 DI in our study.

**TABLE 6: DISTRIBUTION OF PATTERN OF IRIDOPATHY**

| S.NO. | PATTERN OF IRIDOPATHY | NO OF PATIENTS | PERCENTAGE |
|---|---|---|---|
| 1 | ARDL* | 10 | 20% |
| 2 | LOOPS | 2 | 4% |
| 3 | SPROUTS | 1 | 2% |
| 4 | BIFURCATIONS | 1 | 2% |
| 5 | NON-SPECIFIC | 2 | 4% |
| 6 | NORMAL | 34 | 68% |
| 7 | TOTAL | 50 | 100% |

ARDL*-Age Related Dye Leak (considered physiological)

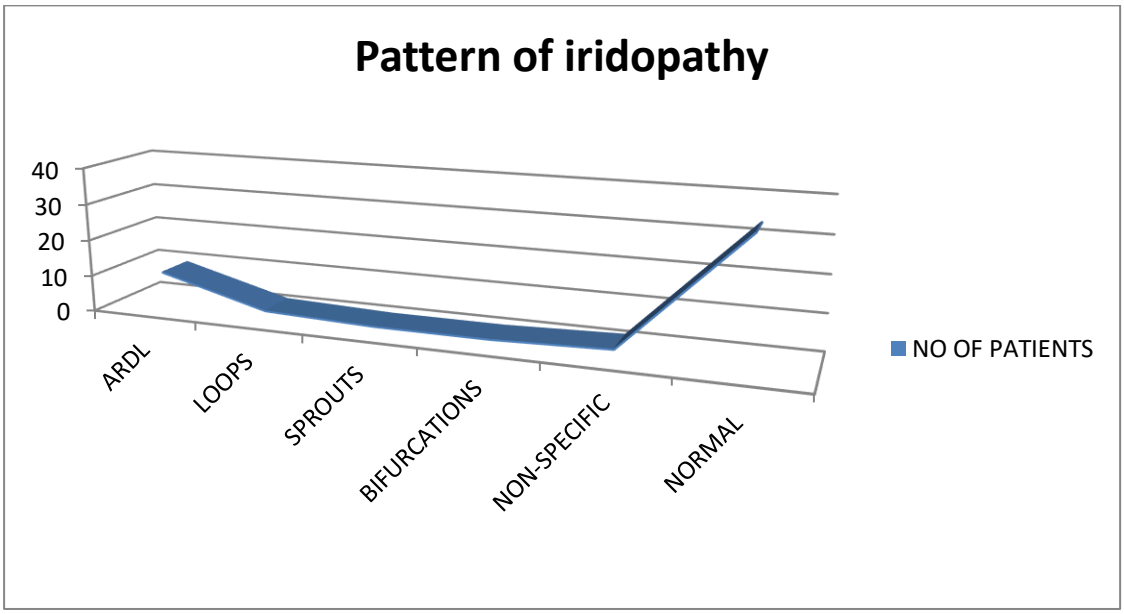
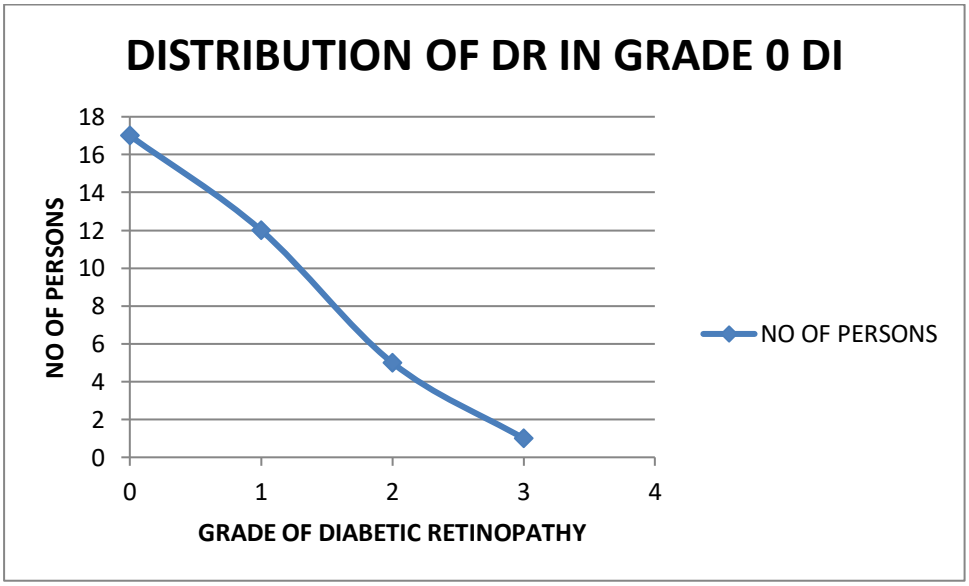


TABLE 6 and GRAPH show the various interesting patterns seen in the iris vasculature during iris fluorescein angiography. About 10 (20%) patients showed transient trivial fluorescein dye leak at the pupillary margin which is considered physiological after 50 years of age. Thus this group was included amongst those with grade 0 DI. 2 persons showed loop pattern while sprout and bifurcation patterns were observed in 1 person each. In 2 patients, though there was a significant fluorescein dye leak no specific pattern could be elicited.

## TABLE 7: DISTRIBUTION OF DIABETIC RETINOPATHY IN PATIENTS WITH GRADE 0 DIABETIC IRIDOPATHY

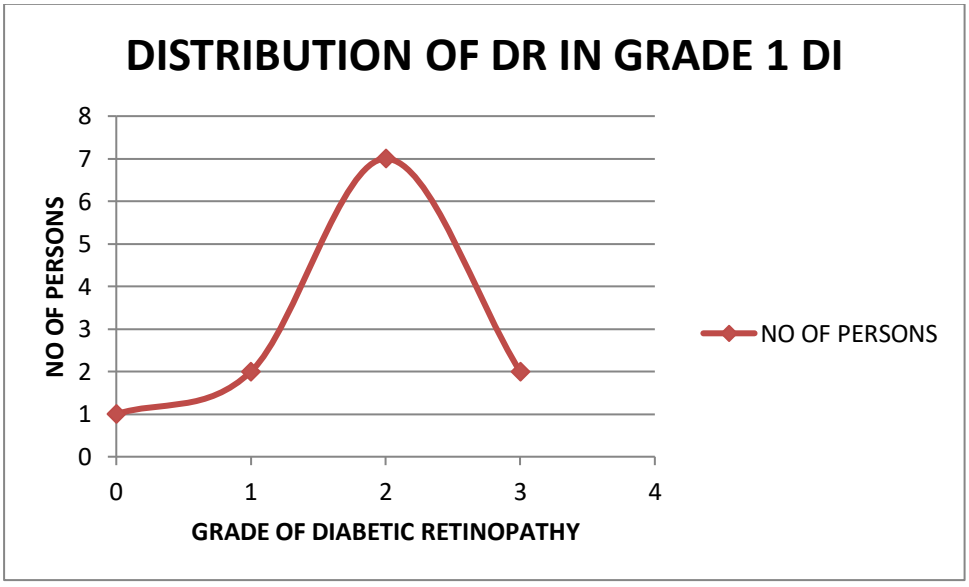
| S.NO | NO OF PATIENTS WITH GRADE 0 DI | GRADE OF DR | NO OF PATIENTS | PERCENTAGE |
|---|---|---|---|---|
| 1 | 35 | GRADE 0 | 17 | 49% |
| 2 | | GRADE 1 | 12 | 34% |
| 3 | | GRADE 2 | 5 | 14% |
| 4 | | GRADE 3 | 1 | 3% |
| 5 | | TOTAL | 35 | 100% |




In table 7 and its corresponding graph we can find that out of 35 patients with Grade 0 DI ,17(49%) had grade 0 DR,12 (34%) had grade 1 DR, 5 (14%) had grade 2 DR while only 1(3%) had grade 3 DR.

**TABLE 8: DISTRIBUTION OF DIABETIC RETINOPATHY IN PATIENTS WITH GRADE 1 DIABETIC IRIDOPATHY**

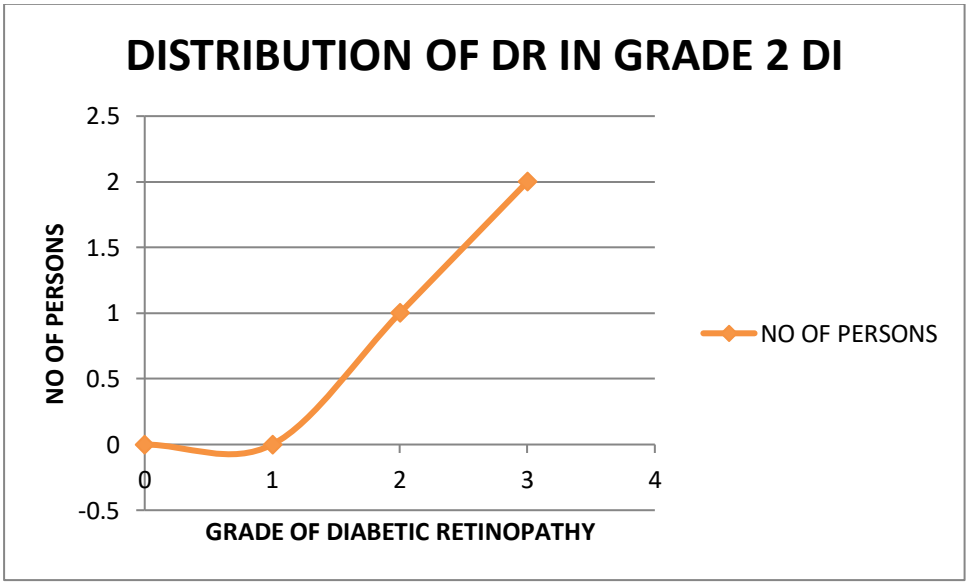
| S.NO | NO OF PATIENTS WITH GRADE 1 DI | GRADE OF DR | NO OF PATIENTS | PERCENTAGE |
|---|---|---|---|---|
| 1 | 12 | GRADE 0 | 1 | 8% |
| 2 | | GRADE 1 | 2 | 17% |
| 3 | | GRADE 2 | 7 | 58% |
| 4 | | GRADE 3 | 2 | 17% |
| 5 | | TOTAL | 12 | 100% |




In table 8 and its corresponding graph ,out of 12 subjects with grade 1 DI , 1, 2,7 and 2 subjects showed Grade0,1,2 and 3 DR respectively. Thus the pre-proliferative vascular changes in the iris tend to occur in more than half the cases of higher grades of NPDR.

**TABLE 9: DISTRIBUTION OF DIABETIC RETINOPATHY IN PATIENTS WITH GRADE 2 DIABETIC IRIDOPATHY**

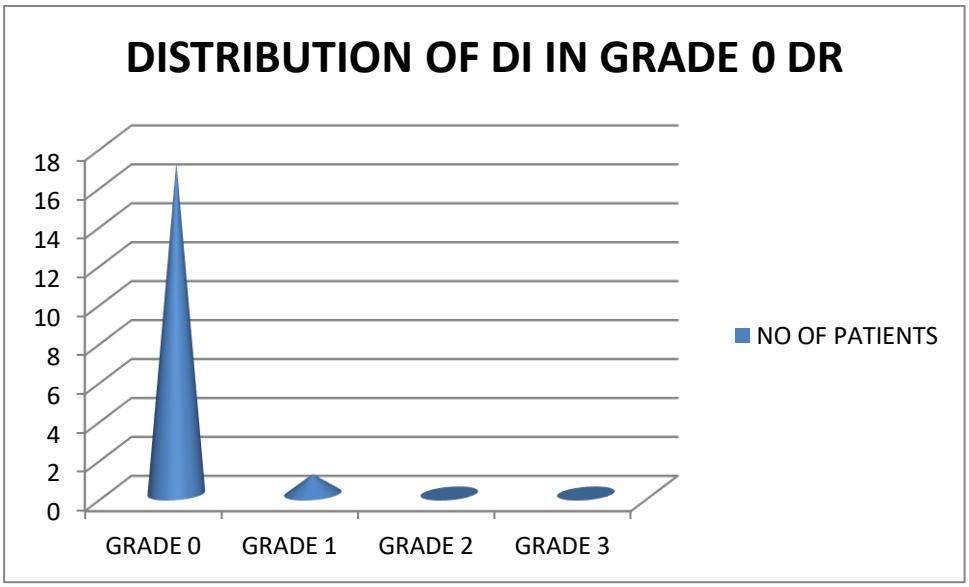
| S.NO | NO OF PATIENTS WITH GRADE 2 DI | GRADE OF DR | NO OF PATIENTS | PERCENTAGE |
|---|---|---|---|---|
| 1 | 3 | GRADE 0 | 0 | 0% |
| 2 | | GRADE 1 | 0 | 0% |
| 3 | | GRADE 2 | 1 | 33% |
| 4 | | GRADE 3 | 2 | 67% |
| 5 | | TOTAL | 3 | 100% |




In Table 9 and corresponding graph, 3 patients showed grade 2 DI out of which 1 (33%) persons had grade 2 DR and 2 (67%) had grade 3 /proliferative DR. This shows the increased sensitivity of IFA in predicting the occurrence of higher grades of NPDR and PDR (compared to slit lamp biomicroscopy).

**TABLE 10: DISTRIBUTION OF DIABETIC IRIDOPATHY IN PATIENTS WITH GRADE 0 DIABETIC RETINOPATHY**

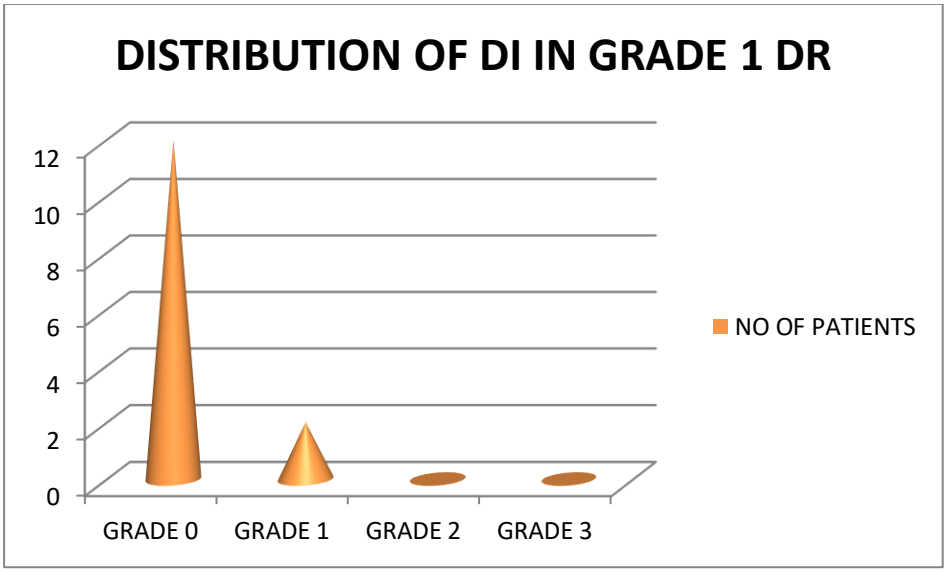
| S.NO | GRADE 0 DR | GRADE OF DI | NO OF PATIENTS | PERCENTAGE |
|---|---|---|---|---|
| 1 | 18 | GRADE 0 | 17 | 95% |
| 2 | | GRADE 1 | 1 | 5% |
| 3 | | GRADE 2 | 0 | 0% |
| 4 | | GRADE 3 | 0 | 0% |
| 5 | | TOTAL | 18 | 100% |




In table 10 and the corresponding graph, the axes are reversed and now the DR severity is correlated with corresponding DI changes. Out of 18 persons with Grade 0 DR almost 95% (17 patients) had no DI while only 1 had grade 1 DI. This indicates the high specificity of IFA in detecting DR.

**TABLE 11: DISTRIBUTION OF DIABETIC IRIDOPATHY IN PATIENTS WITH GRADE 1 DIABETIC RETINOPATHY**

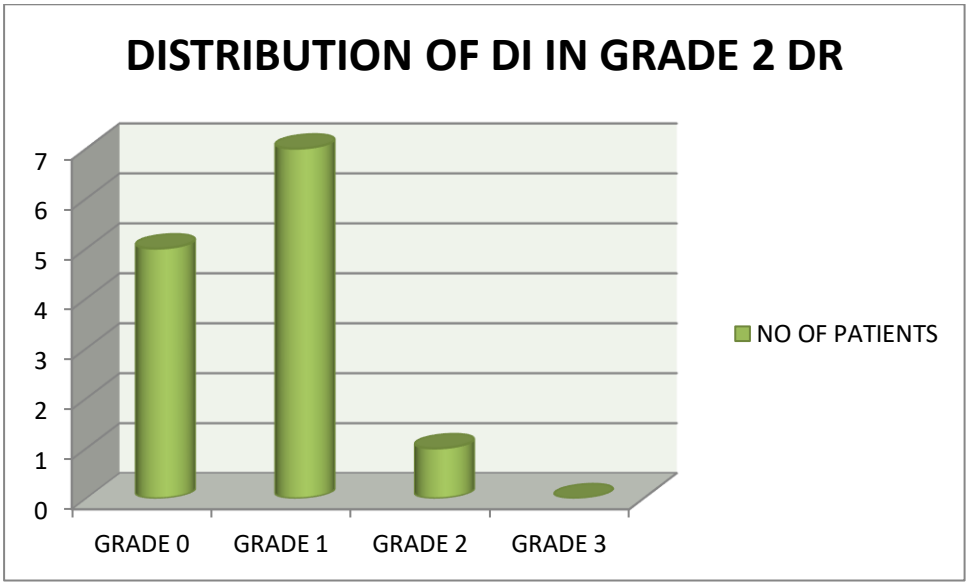
| S.NO | GRADE 1 DR | GRADE OF DI | NO OF PATIENTS | PERCENTAGE |
|---|---|---|---|---|
| 1 | 14 | GRADE 0 | 12 | 85% |
| 2 | | GRADE 1 | 2 | 15% |
| 3 | | GRADE 2 | 0 | 0% |
| 4 | | GRADE 3 | 0 | 0% |
| 5 | | TOTAL | 14 | 100% |




In Table 11 and its corresponding graph out of 14 patients with grade 1 DR , 12(85%) showed grade 0 DI and 2 showed grade 1 DI. This equivocal results are to be interpreted thus with caution.

**TABLE 12: DISTRIBUTION OF DIABETIC IRIDOPATHY IN PATIENTS WITH GRADE 2 DIABETIC RETINOPATHY**

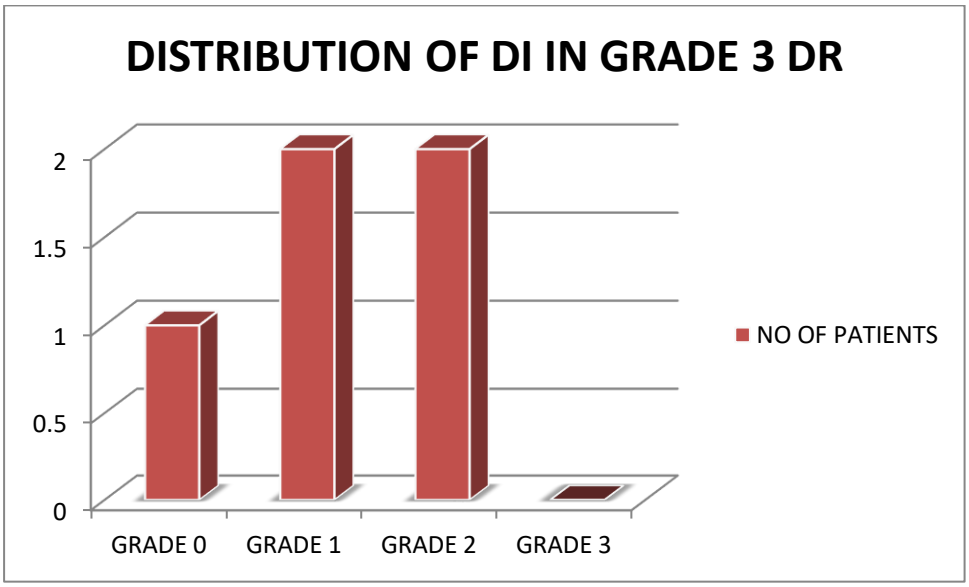
| S.NO | GRADE 2 DR | GRADE OF DI | NO OF PATIENTS | PERCENTAGE |
|---|---|---|---|---|
| 1 | 13 | GRADE 0 | 5 | 38% |
| 2 | | GRADE 1 | 7 | 54% |
| 3 | | GRADE 2 | 1 | 8% |
| 4 | | GRADE 3 | 0 | 0% |
| 5 | | TOTAL | 13 | 100% |




In table 12 and its corresponding graph ,out of 13 subjects who had grade 2 DR , 7 (54%) had grade 0 DI, 7 (54%) had grade 1 DI and 1 (8%) had grade 2 DI. Here too IFA predicted NPDR in more than 50% of patients.

**TABLE 13: DISTRIBUTION OF DIABETIC IRIDOPATHY IN PATIENTS WITH GRADE 3 DIABETIC RETINOPATHY**

| S.NO | GRADE 3 DR | GRADE OF DI | NO OF PATIENTS | PERCENTAGE |
|---|---|---|---|---|
| 1 | 5 | GRADE 0 | 1 | 20% |
| 2 | | GRADE 1 | 2 | 40% |
| 3 | | GRADE 2 | 2 | 40% |
| 4 | | GRADE 3 | 0 | 0% |
| 5 | | TOTAL | 5 | 100% |




In Table 13 and its corresponding graph the silent presence of proliferative retinal changes were brought to lime light by IFA in about of 80%(4)of cases while only 1 person's retina fooled the angiography. This indicates excellent specificity of IFA in predicting proliferative changes of retina so that the surgeon is not in for a surprise during or post cataract surgery.

**TABLE 14: OVERALL CORRELATION OF DIABETIC RETINOPATHY WITH IRIDOPATHY**

| | Grade 0 DI | Grade 1 DI | Grade 2 DI | Grade 3 DI | Total |
|---|---|---|---|---|---|
| **Grade 0 DR** | 17(49%) | 1(8%) | 0 | 0 | 18(36%) |
| **Grade 1 DR** | 12(34%) | 2(17%) | 0 | 0 | 14(28%) |
| **Grade 2 DR** | 5(14%) | 7(58%) | 1(33%) | 0 | 13(26%) |
| **Grade 3 DR** | 1(3%) | 2(17%) | 2(67%) | 0 | 5(10%) |
| **Total** | 35 | 12 | 3 | 0 | 50 |

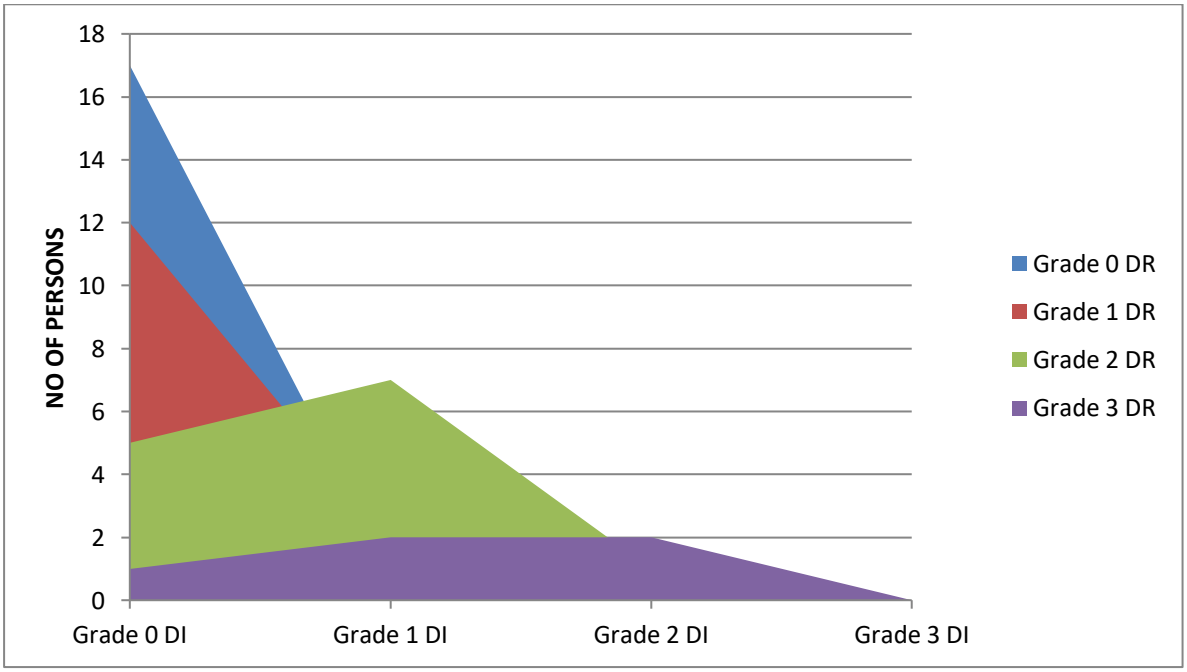



Table 14 and its corresponding graph shows that the sensitivity of IFA in detecting DR is 43.82% and specificity is 96.07%. The positive predictive value of IFA is 95.12% and Negative predictive value is 49.49%.

**TABLE 15: STATISTICAL ANALYSIS**

| | Grade 0/1 DI | Grade 2/3 DI | Total |
|---|---|---|---|
| Grade 0/ 1 DR | 32 | 0 | 32(64%) |
| Grade2 / 3 DR | 15 | 3 | 18(36%) |
| Total | 47 | 3 | 50 |

From the above table, the 95% Confidence Interval (CI) was calculated to be 37.11 and 65.92. The two-tailed p value was calculated with the Fisher's exact test with and was found to be 0.0416, thus being statistically significant. The coefficient of correlation is 0.6119 and the coefficient of determination being 0.3744. This means that the clinically seen correlation between the Diabetic Retinopathy and Iridopathy in our study is also statistically significant proving the usefulness of Iris Fluorescein Angiography in predicting DR again.

## DISCUSSION:

Diabetic iridopathy has long been known as the silent thief of vision as it is often overlooked in the background of the more obvious and common diabetic retinopathy. The dense brown melanocytes present in most of the Indian iris and lack of appropriate technology to reliably study the pattern of flow of blood through the iris vasculature has lead to slit lamp examination of the iris as one of the sole clinical gateway for detecting abnormal iris vasculature.

However, slit lamp confesses only the severe and obvious degrees of iris vasculature abnormalities when the retinal vasculature abnormalities have already reached ominous proportions, many a times only at the penultimate stage of neovascular glaucoma.

In our study, we try to re-establish the long forgotten role of iris fluorescein angiography in early detection of iris vasculature abnormalities and thus be of more help in predicting the retinal status in patients with diabetes in whom dense cataract is precluding the ophthalmoscopic fundus view.

In diabetic patients it is important that we establish what type of retinopathy is behind a cataract or other type of dioptric media opacity, because serious complications can develop in a patient operated on without this knowledge.

In our study, we have non-randomly chosen chronic diabetics with dense cataract who are not found to have any other systemic or ocular causes which can alter the vascular of the eyes and alter the outcome.

The mean age of the subjects in our study was approximately 60 years.

Here as the cataracts of higher grades which precluded the fundus view were only selected and so typical juvenile diabetic cataracts ( Snow flake) were not included here. Also, 92% of our subjects were Type 2 Diabetics forming the major chunk as expected.

There is increased prevalence of Diabetic Retinopathy here (64%) as compared to its overall prevalence in diabetic patients (which is 18%, according to a study conducted by Salil S Gadkari et al at New Delhi in 2014) because only chronic diabetics with majority around 60 years of age with dense cataract were included in our study. The mean duration of Diabetes Mellitus in our study population was 10 years.

The prevalence of Diabetic iridopathy was 30% in our study. There were no other proper Indian studies which estimated the prevalence of iridopathy reliably. Majority had no significant diabetic changes in their iris (i.e.35 patients {70%}). Fortunately, there were no patients in our study with grade 3 iridopathy because of its relatively rare occurrence and also that such an obvious degree of

iridopathy was revealed during the slit lamp examination itself and thus were likely to be excluded.

Fluorescein dye leakage (Age Related Dye leak) which was transient and trivial with no specific pattern along the pupillary border is considered physiological after 50 years of age and thus included in the grade 0 Diabetic iridopathy group. But it needs a considerable practice and experience to brand a patient with dye leakage as having no iridopathy. In case of an equivocal finding it is better to err on the side of iridopathy in order to avoid surprises on the table or post operatively after cataract surgery. Some recognisable patterns of abnormal iris vasculature were observed viz. loops, bifurcations and sprouts. But such patterns showed no significant correlation to the severity of iridopathy nor were they specific for diabetic iridopathy.

In spite of extensive search for relevant images and study materials we couldn't make out a recognizable iris fluorescein angiographic pattern in 2 patients who showed significant dye leak.

According to our study IFA is found to have a low sensitivity (about 14%) and excellent specificity (about 95%) in predicting absence or presence of lower grades of Diabetic Retinopathy. Though it is still far from acceptable there is no other method which identifies early iridopathy as reliably as IFA. However, the sensitivity (about 67%) and specificity (100%) of IFA in predicting higher grades of NPDR is substantially high which thus reinforces

its role in heralding the occurrence of proliferative DR well ahead of clinical fundus changes.

Our study is comparable to the one done by Francesco Bandello et al on "Relation between iridopathy and retinopathy in diabetes" done in 1994 in 225 eyes of 117 diabetics with clear media. The overall sensitivity of iris fluorescein angiography in assessing DR in that study was 44.5%, the specificity 88%, the positive predictive value 92.8%, and the negative value 31.2%. These values are on par more or less with our study- Overall sensitivity being 28.57% and specificity being 94.44%. The positive predictive value being 93.33% and the negative predictive value being 48.57%. In their study,in pre-proliferative and proliferative DR, fluoroiridographic detection of iris neovessels gave a sensitivity of 56% (compared to 14% in our study) and a specificity of 100%(95% in our study).

Our results basically also confirm those of Algvere and Kornacki, even though they used a different method of classification of DI and DR.

To sum up, iris fluorescein angiography yields valuable information on DR and is a helpful basis for avoiding complications when scheduling eyes with dioptric media opacities for surgery.

## CONCLUSION:

Using iris angiography we were able to detect the eyes with the most serious forms of DR - that is, those most likely to present major complications during and following surgery.

Clinically, when iris neovascularisation is detected in an eye in which it is impossible to evaluate retinopathy because of opacity in the lens or other media, concomitant serious retinopathy must be presumed, and therefore great care must be taken in the management of the eye. Before cataract extraction or vitrectomy, cryocoagulation or transscleral photocoagulation or intravitreal Anti VEGF must be seriously considered to destroy the non-perfused peripheral areas of the retina. Sometimes endophotocoagulation carried out in the course of pars plana vitrectomy, or photocoagulation done in the early post op can produce just as good results.

Above all, iris fluorescein angiography is a valuable diagnostic, non-invasive procedure. It also provides more information regarding intergrity of blood retinal barrier even in an opaque media.

Our study thus proves the vast superiority of Iris fluorescein angopgraphy over slit lamp examination in detecting iris vasculature abnormalities well ahead.

## LIMITATIONS OF THIS STUDY:

1) Less of mature cataract seen in young Type 1 Diabetes Mellitus and so inadequate subjects to study pattern of IFA in these patients.

2) Grade III diabetic iridopathy was not seen in any of our subjects and so the pattern of DR in Grade 3 DI was not able to be established.

3) Less useful in patients with no iridopathy.

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## ANNEXURE II-ABBREVIATIONS USED IN THIS STUDY

**DR**- DIABETIC RETINOPATHY

**DI**- DIABETIC IRIDOPATHY

**DD**- DISC DIAMETER/DISC DIOPTER

**NVG**- NEOVASCULAR GLAUCOMA

**IFA**- IRIS FLUORESCEIN ANGIOGRAPHY

**FFA**- FUNDUS FLUORESCEIN ANGIOGRAPHY

**MA**- MICRO ANEURYSMS

**BDR**- BACKGROUND DIABETIC RETINOPATHY

**NVD**- NEOVASCULARISATION OF DISC

**NVE**- NEOVASCULARISATION ELSEWHERE

**CSME**- CLINICALLY SIGNIFICANT MACULAR EDEMA

**IRMA**- INTRA RETINAL MICROVASCULAR ANOMALIES

**NPDR**-NON PROLIFERATIVE DIABETIC RETINOPATHY

**PDR**- PROLIFERATIVE DIABETIC RETINOPATHY

**CRVO**- CENTRAL RETINAL VEIN OCCLUSION

**PRP**- PAN RETINAL PHOTOCOAGULATION

**VEGF**- VASCULAR ENDOTHELIAL GROWTH FACTOR

**PEDF**- PIGMENT EPITHELIUM DERIVED FACTOR

**ETDRS**- EARLY TREATMENT OF DIABETIC RETINOPATHY STUDY

**PRH**- PRE RETINAL HEMORRHAGE

**VH**- VITREOUS HEMORRHAGE

**ARMD**- AGE RELATED MACULAR DEGENERATION

**RPE**- RETINAL PIGMENT EPITHELIUM

**μ**- MICRON

**nm**- NANOMETRE

**mm**- MILLIMETRE

**cm**-CENTIMETRE

**m**- METRE

# ANNEXURE III-MASTER CHART

| S. NO | PATIENT NAME | AGE/ SEX | TYPE OF DIABETES | DURATION OF DIABETES | GRADE OF DI | GRADE OF DR | PATTERN OF DI |
|---|---|---|---|---|---|---|---|
| 1 | POONGODI | 32/F | TYPE 2 | RECENTLY DIAGNOSED | grade 0 | grade 0 | ARDL |
| 2 | MARIYAPPAN | 60/M | TYPE 2 | 10 YEARS | grade 1 | grade 3 | |
| 3 | CHELLAMMAL | 56/F | TYPE 2 | 3 YEARS | grade 0 | grade 0 | |
| 4 | MARUTHAYEE | 60/F | TYPE 2 | 7 YEARS | grade 1 | grade 0 | |
| 5 | ROSALIN MARY | 55/F | TYPE 2 | 8 YEARS | grade 0 | grade 0 | |
| 6 | DHANRAJ | 70/M | TYPE 2 | 15 YEARS | grade 1 | grade 2 | LOOP |
| 7 | AYYAMMAL | 64/F | TYPE 2 | 8 YEARS | grade 0 | grade 1 | ARDL |
| 8 | PONNAMMAL | 59/F | TYPE 2 | 10 YEARS | grade 0 | grade 1 | |
| 9 | THANGARAJ | 47/M | TYPE 1 | 20 YEARS | grade 1 | grade 3 | |
| 10 | MADHAIYAN | 58/M | TYPE 2 | 10 YEARS | grade 0 | grade 1 | |
| 11 | PONNANGAN | 64/M | TYPE 2 | 10 YEARS | grade 1 | grade 2 | |
| 12 | ADAIKKALAMARY | 50/F | TYPE 2 | RECENTLY DIAGNOSED | grade 0 | grade 0 | |
| 13 | RAJAMOHAN | 52/M | TYPE 1 | 30 YEARS | grade 2 | grade 3 | LOOP |
| 14 | MOHAMED ASIF | 62/M | TYPE 2 | 10 YEARS | grade 0 | grade 1 | |
| 15 | ANGELMARY | 55/F | TYPE 2 | 7 YEARS | grade 0 | grade 0 | |
| 16 | VASANTHA | 54/F | TYPE 2 | 8 YEARS | grade 0 | grade 1 | |
| 17 | PERUMAN | 80/M | TYPE 2 | RECENTLY DIAGNOSED | grade 0 | grade 0 | |
| 18 | RAHUMAN | 68/M | TYPE 2 | 10 YEARS | grade 0 | grade 2 | |
| 19 | PERUMAYEE | 69/F | TYPE 2 | 12 YEARS | grade 0 | grade 1 | |
| 20 | CHINNATHAYEE | 60/F | TYPE 2 | 5 YEARS | grade 0 | grade 0 | |
| 21 | SHANMUGAM | 58/M | TYPE 2 | 5 YEARS | grade 0 | grade 0 | SPROUTS |
| 22 | RAJAMANI | 50/M | TYPE 2 | RECENTLY DIAGNOSED | grade 0 | grade 1 | |
| 23 | KAMALA | 60/F | TYPE 2 | 12 YEARS | grade 0 | grade 2 | |
| 24 | AZHAGARMALAI | 75/M | TYPE 2 | 20 YEARS | grade 2 | grade 3 | NON SPECIFIC |
| 25 | PERUMAL | 53/M | TYPE 2 | 14 YEARS | grade 1 | grade 2 | |
| 26 | PECHIYAMMAL | 67/F | TYPE 2 | 10 YEARS | grade 0 | grade 1 | ARDL |
| 27 | MOOKKAMMAL | 65/F | TYPE 2 | 5 YEARS | grade 0 | grade 0 | ARDL |
| 28 | VEERNAN | 70/M | TYPE 2 | 15 YEARS | grade 1 | grade 2 | ARDL |
| 29 | VELAMMAL | 64/F | TYPE 2 | 8 YEARS | grade 0 | grade 0 | |
| 30 | VARADHAMMAL | 68/F | TYPE 2 | RECENTLY DIAGNOSED | grade 0 | grade 1 | |
| 31 | VISALAKSHI | 57/F | TYPE 2 | 5 YEARS | grade 0 | grade 2 | |
| 32 | FATHIMA BEEVI | 60/F | TYPE 2 | 4 YEARS | grade 0 | grade 0 | |
| 33 | MUTHAMMAL | 65/F | TYPE 2 | 2 YEARS | grade 0 | grade 0 | |
| 34 | CHANDRA | 59/F | TYPE 1 | 25 YEARS | grade 1 | grade 2 | BIFURCATIONS |
| 35 | SEKAR | 61/M | TYPE 2 | 5 YEARS | grade 0 | grade 1 | |
| 36 | RAKKAMMAL | 63/F | TYPE 2 | 4 YEARS | grade 0 | grade 0 | ARDL |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 37 | RENGUMANI | 60/F | TYPE 2 | RECENTLY DIAGNOSED | grade 0 | grade 0 | |
| 38 | UDAYANAATCHI | 62/F | TYPE 2 | 9 YEARS | grade 0 | grade 2 | ARDL |
| 39 | RAJA | 60/M | TYPE 2 | RECENTLY DIAGNOSED | grade 0 | grade 0 | |
| 40 | RAVINDRAN | 55/M | TYPE 2 | 5 YEARS | grade 0 | grade 1 | |
| 41 | MURUGESAN | 70/M | TYPE 2 | 15 YEARS | grade 1 | grade 2 | |
| 42 | PANDIYAN | 60/M | TYPE 2 | 5 YEARS | grade 0 | grade 0 | |
| 43 | ESAKIYAMMAL | 62/F | TYPE 2 | 10 YEARS | grade 0 | grade 0 | ARDL |
| 44 | NOORJAHAN | 60/F | TYPE 2 | RECENTLY DIAGNOSED | grade 0 | grade 1 | |
| 45 | VAAZHAVANDHAN | 68/M | TYPE 2 | 7 YEARS | grade 0 | grade 3 | ARDL |
| 46 | AARAYEE | 60/F | TYPE 2 | 10 YEARS | grade 1 | grade 1 | |
| 47 | KAJA MAIDEEN | 40/M | TYPE 1 | 15 YEARS | grade 1 | grade 2 | |
| 48 | LAKSHMIAMMAL | 70/F | TYPE 2 | 25 YEARS | grade 2 | grade 2 | NON SPECIFIC |
| 49 | PANCHAMMAL | 50/F | TYPE 2 | 12 YEARS | grade 1 | grade 1 | |
| 50 | KOOLU | 67/M | TYPE 2 | 6 YEARS | grade 0 | grade 2 | ARDL |

## ANNEXURE IV- PROFORMA

**NAME:** **AGE:** **SEX:**

**ADDRESS:** **PHONE NUMBER:**

**CHIEF COMPLAINTS**

**H/O PRESENTING ILLNESS**

**PAST MEDICAL AND SURGICAL HISTORY**

**TREATMENT HISTORY**

**FAMILY HISTORY**

**PERSONAL HISTORY**

**SOCIOECONOMIC HISTORY**

## GENERAL EXAMINATION

**BUILT-**

**NOURISHMENT-**

**ORIENTATION-**

**PALLOR-**

**ICTERUS-**

**CYANOSIS-**

**CLUBBING-**

**DEPENDENT EDEMA-**

**SIGNIFICANT GENERALISED LYMPHADENOPATHY-**

**BP-**

**PULSE-**

**FACIAL SYMMETRY-**

**HEADPOSTURE-**

**SWELLING/ULCER/ANY LESION IN ANY PART(S) OF THE BODY-**

## OBLIQUE EXAMINATION OF EYES

**UNCORRECTED VISUAL ACUITY-**

**VISUAL ACUITY WITH PINHOLE-**

| OD | STRUCTURE EXAMINED | OS |
|---|---|---|
| | LIDS | |
| | CONJUCTIVA | |
| | CORNEA | |
| | ANTERIOR CHAMBER | |
| | IRIS | |
| | PUPILS | |
| | LENS | |

## SLIT LAMP EXAMINATION

| OD | STRUCTURE EXAMINED | OS |
|---|---|---|
| | LIDS | |
| | CONJUCTIVA | |
| | CORNEA | |
| | ANTERIOR CHAMBER | |
| | IRIS | |
| | PUPILS | |
| | LENS | |

**INTRAOCULAR PRESSURE AS MEASURED BY GOLDMANN APPLANATION TONOMETRY-**

**GONIOSCOPY-**

## DILATED FUNDUS EXAMINATION

## (FIRST WITH DIRECT OPHTHALMOSCOPY AND THEN WITH SLITLAMP BIOMICROSCOPY WITH +90 LENS)

## (INCASE A VIEW IS PRESENT IN ANY ONE OF THE EYES)

| OD | | OS |
|---|---|---|
| | MEDIA | |
| | DISC | |
| | CUP-DISC RATIO | |
| | VESSELS | |
| | AV RATIO | |
| | MACULA | |
| | FR | |

**A-SCAN REPORT-**

**B-SCAN REPORT-**

**DIAGNOSIS-**

## INVESTIGATIONS

**FASTING BLOOD GLUCOSE-**

**POST PRANDIAL BLOOD GLUCOSE-**

**HbA1c-**

**RENAL FUNCTION TESTS-**

**SERUM ELECTROLYTES-**

**BLOOD HEMOGLOBIN-**

**URINE SUGAR, ACETONE, CELLS, ALBUMIN-**

**VIRAL MARKERS FOR SYPHILIS, HIV AND HEPATITIS B AND C-**

**ELECTROCARDIOGRAM-**

**ULTRASONOGRAM -ABDOMEN AND PELVIS-**

## OTHER SPECIALITY OPINION AND FITNESS (IF NECESSARY)

**GENERAL PHYSICIAN-**

**DIABETOLOGIST-**

**NEPHROLOGIST-**

**ANAESTHETIST-**

## IRIS FLUORESCEIN ANGIOGRAPHY

**OD-**

**OS-**

## POST CATARACT SURGERY

**SLIT LAMP EXAMINATION**

**VISUAL ACUITY (ON THE 2ND POST OPERATIVE DAY)**

**OPHTHALMOSCOPIC FUNDUS EXAMINATION**

**FUNDUS FLUORECEIN ANGIOGRAPHY (DONE ATLEAST 48 HRS AFTER IFA)**

## CORRELATION AND CONCLUSION

## ANNEXURE V- CONSENT FORM IN REGIONAL LANGUAGE (TAMIL)

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# ANNEXURE VI-  RECEIPT FOR PLAGIARISM

S.MURALI KRISHNAN

PG RESIDENT ,(M.S OPHTHALMOLOGY)

MADURAI MEDICAL COLLEGE

EXAMINATION NUMBER: 221513101

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Document : PLAGIRISM IFA.docx [D31048080]

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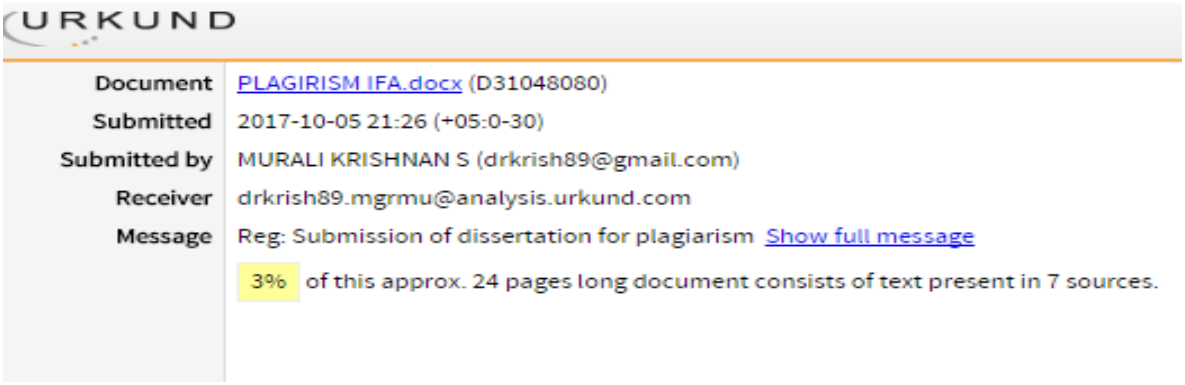


# ANNEXURE VII- CERTIFICATE OF ETHICAL CLEARANCE

# MADURAI MEDICAL COLLEGE
## MADURAI, TAMILNADU, INDIA -625 020
(Affiliated to The Tamilnadu Dr.MGR Medical University,
Chennai, Tamil Nadu)



## *ETHICS COMMITTEE CERTIFICATE*

| | | |
|---|---|---|
| Name of the Candidate | : | Dr.S.Muralikrishnan |
| Course | : | PG in MS., Ophthalmology |
| Period of Study | : | **2015-2018** |
| College | : | **MADURAI MEDICAL COLLEGE** |
| Research Topic | : | A cross-sectional study to determine the role of Iris fluorescein angiography in chronic diabetic patients before cataract surgery |
| Ethical Committee as on | : | 21.04.2017 |

The Ethics Committee, Madurai Medical College has decided to inform that your Research proposal is accepted.

Member Secretary  Chairman  Dean / Convenor

Prof Dr V Nagaraajan
M.D., MNAMS, D.M., Dsc.,(Neuro), Dsc (Hon)
CHAIRMAN
IEC - Madurai Medical College
Madurai

DEAN
Madurai Medical College
Madurai-20