Dissertation on

AN OBSERVATIONAL STUDY TO STUDY THE PATTERN OF OPTIC NERVE HEAD FILLING IN FUNDUS FLOURESCEIN ANGIOGRAPHY IN HYPERTENSIVE PATIENTS WITH NORMAL AND CROWDED OPTIC DISC

Submitted in partial fulfillment of requirements of

M.S. DEGREE

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CERTIFICATE – I

This is to certify that this dissertation entitled "**AN OBSERVATIONAL STUDY TO STUDY THE PATTERN OF OPTIC NERVE HEAD FILLING IN FUNDUS FLOURESCEIN ANGIOGRAPHY IN HYPERTENSIVE PATIENTS WITH NORMAL AND CROWDED OPTIC DISC"** is the bonafide original work of **Dr. P. JAYA DURGA DEVI**, 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 2020.

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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 2020.

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The Arterial blood supply of the optic nerve head :

The blood supply of the optic nerve head can be best discussed under the following 4 regions, from anterior to posterior aspect

(1) **The surface nerve fiber layer part:** This is the most anterior part of the optic nerve head (surface of the optic disc) and is typically supplied by the retinal arterioles . In some case, its temporal region may instead be supplied by the posterior ciliary artery (PCA) circulation from the deeper prelaminar region.

The cilio-retinal artery (rarely a tiny cilio-papillary artery), usually supplies the corresponding sector of the surface layer if present.

(2) **The prelaminar part**:

This portion lies between the surface nerve fiber layer and the lamina cribrosa. It is usually supplied by the fine centripetal branches from the peripapillary choroid which gives out branches to the corresponding part of the prelaminar region, as shown by a large number of fluorescein angiographic and morphological studies, with the former providing the most convincing information about the blood supply.

But , a few papers based purely on postmortem morphological studies have said that this is not so.

The peripapillary choriocapillaris and central retinal artery (CRA)does not play role in its supply. Our clinical and experimental fluorescein angiographic studies have shown a sectoral blood supply in this region , that agrees with the overall segmental distribution of the PCA circulation as well as the segmental nature of visual loss in optic nerve head ischemic disorders.

Many experimental and clinical studies have demonstrated selective filling delay or the non-filling of the peripapillary choroid in AION, GON and ocular hypertension.

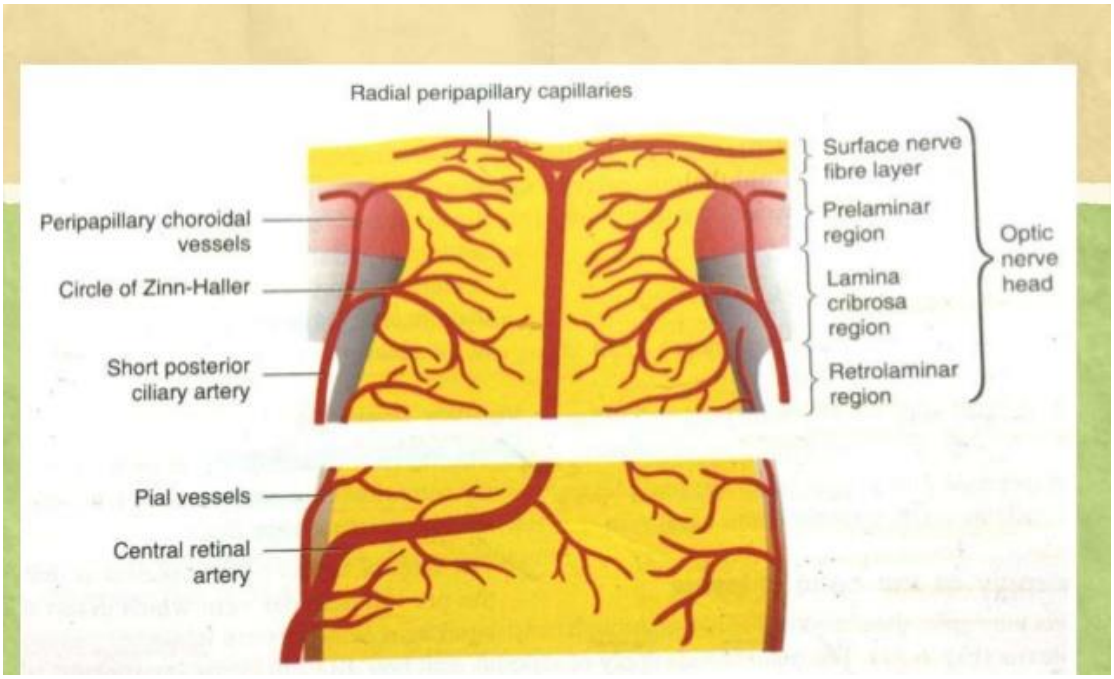
(3) **Lamina cribrosa part:**

This region of the ONH is entirely supplied by centripetal branches from the short PCAs, either directly or from the circle of Haller and Zinn (CHZ) formed by the short PCAs , if present.

A reasearched named Ducournau designated that these short PCAs as ‘‘paraoptic short PCAs’’ and reported branches from them to the peripapillary choroid, the CHZ and recurrent branches to the pial vascular plexus. The central retinal artery does not give branches in this part.

Few anatomists named Wolff and Lieberman et al. are the only authors who have claimed to have traced a capillary branch in this region

from the central retinal artery in three eyes on histological studies of the blood vessels and optic nerve head.



(d) **Retrolaminar part:**

This region of the optic nerve head will be immediately behind the lamina cribrosa. It can have a dual source of blood supply .

(1) The Peripheral centripetal vascular supply: This will be always present and is formed by the pial vascular plexus. The main sources of blood supply to the pial vascular plexus will be the recurrent pial branches arising from the CHZ or the short PCAs in that area, and the peripapillary choroid.

The recurrent branches usually run backward in the pia of the retrolaminar region. But In addition to those, pial branches from the central retinal artery and other orbital arteries can also contribute to the supply.

(2) The Axial and centrifugal vascular supply:

This can be an inconstant source of supply and is usually derived from the branches of the central retinal artery, if these artery gives out any branch suppose.

Both centripetal pial vessels as well as the centrifugal vessels if present run in the septa of the nerve, so that the optic nerve septa will be in fact fibrovascular in nature.

From the description of the blood supply of the optic nerve head it becomes clear that the prime source of blood supply to the optic nerve head is the PCA circulation.

Venous drainage of the optic nerve head :

This will be essentially through the central retinal vein except that the prelaminar region gets drained into the peripapillary choroidal veins. The communication gets importance for development of retino-ciliary collaterals (falsely called opto-ciliary shunts) in the event of central retinal vein occlusion posterior to the lamina cribrosa.

Vascular architecture of the optic nerve head :

Many investigators since 1903 have described this, on light microscopy as well as, more recently, scanning electron microscopy.

The vessels in the optic nerve head lie in the septa so that the distribution of the septa is probably a distribution of the blood vessels. These capillaries form two basic type of patterns in the retrolaminar portion of the optic nerve - longitudinal and transverse patterns.

These longitudinal capillaries usually run in between the nerve fiber bundles antero-posteriorly, whereas the transverse capillaries encircles the various nerve bundles at regular intervals and can form a complete or incomplete pentagonal, oval or round network of vessels.

Collaterals from both the longitudinal and transverse network of capillaries join to form a complicated capillary plexus which is difficult to delineate. The vessel architecture in the area of lamina cribrosa has been mentioned as comprising many, small, very close and transversely elongated meshes ,a very dense capillary plexus ,ten to twenty millimetre in diameter which makes this part of the optic nerve head a heavily vascular structure .

In the histological studies by prominent anatomist It has been found that the capillaries in the lamina cribrosa region were arranged mostly transversely, like the connective tissue septa in that region and in the prelaminar region, the arrangement was similar to that in the retrolaminar region; in the retrolaminar part of the optic nerve head the longitudinal and

transverse pattern of capillaries formed a complicated meshwork of capillaries .

The peripapillary type of choriocapillaris do not get anastomosed with the capillaries as plexus of vessels in the prelaminar region. In the optic nerve head part the capillaries form a continuous network of vessels throughout its entire length, that is continuous posteriorly with that in the rest of the optic nerve and anteriorly with the adjacent capillaries of the retina.

Circle of Haller and Zinn and the significance of its role in the blood supply of the optic nerve head :

Haller and Zinn described the arterial circle of haller and zinn in 1754 and 1755 respectively ,are situated in the peripapillary sclera and are formed by the anastomoses between the posterior ciliary arteries , and their existence are often been reported, in the later half of twentieth century by many authors in various periods.

But , their prevalence and what the arterial circle supplies and how often it would be a complete or incomplete circle have always been controversial even after various studies . Now recently scanning electron microscopic examination of the plastic microvascular corrosion casts of the

human optic nerve head vessels have provided a detailed information in the circle of haller and zinn.

Reports regarding the prevalence in the human eyes have varied among various studies and described differently by various authors. For example

(1)ollver et al in 1994 have found that it is present in more than 75% of the 18 casts of ONH,

(2) Onda et al described that in 61% of the 18 eyes studied and

(3) Gauntt et a in 1999 demonstrated that in 83% of 29 eyes studied.

It is commonly accepted that the circle of zinn and haller usually give three sets of branches:

1. to the lamina cribrosa,

2. to the peripapillary choroid and

3. recurrent pial branches to the retrolaminar region .

The CHZ can be eloborated as a microscopic, intrascleral, elliptical, microvascular anastomosis of arterioles which are formed by the branches of the medial and lateral paraoptic short posterior ciliary arteries; It has been preferred to mention the CHZ as the ‘‘perioptic nerve arteriolar anastomoses’’ of the optic nerve head.

As per the studies , the complete or incomplete ellipse of arteriolar network is divided into superior and inferior portions by the entry points of these branches into the eye and they will show morphological variations , the variations can be interindividual and interoptic in the same patient , described in terms of the form, position and branches of these arterioles.

Out of the eighteen casts of the CHZ which were examined by the authors in the olver et al study , they found that the complete anastomoses is present in 8 cases which is around 44%, complete with the narrowed sections in 6 cases which is around 33% and somewhat incomplete anastomoses in 4 cases which is around 23%.

This Circle has been supplied by the branches of the medial and lateral paraoptic short posterior ciliary arteries in 15 cases which will be 83%, lateral paraoptic short posterior ciliary arteries in 2 of the cases which will be 11%, and medial, lateral and superior short posterior ciliary arteries in only one case which is 6% .

It has been concluded that the circle of zinn haller lies in different planes anteroposteriorly which resembles like a hammock (they describe it as a hammock which means a rope bed which is supported at the two ends by the cords) and this circle has both the extrascleral and intrascleral portions. It has been found that branches from the circle of zinn haller there exists an arteriolar-arteriolar anastomoses which is important.

In another study done by Onda et al in 1995 , they examined eighteen casts and they found that the circle of zinn haller is formed by the branches ofthe short posterior ciliary arteries.

It has been found that there was a complete anastomotic arterial circle surrounding the optic nerve head in two of eleven eyes involved in the study or a well-developed anastomotic arterial circle surrounding the ONH in nine of the eleven eyes studied , which is usually located approximately 200–300 mm posterior to the suprachoroidal space and also within the perineural sclera.

In a study by Gauntt et al., they did a serial sectioning of 29 eyes . It has been found that the CHZ is incomplete in and narrow in eight of the twenty nine eyes. They described two types of position of the circle of zinn haller in the sclera around the optic nerve head . In the Type 1 , the location or the site was lateral to the site of attachment of the dural sheath to the sclera and it has been found in twenty eyes which is around sixty nine percent and in Type 2 it was found medial to the sheath which was found in four eyes which contributes around 13.6 % and the CHZ was more medially located in small optic discs rather than the large and normal optic discs.

They finally postulated that a combination of small disc which often has a medial displacement of the CHZ, and this anatomical variation

in the vascular pattern of the chz may predispose to an optic nerve head ischemic events.

In another study by Strek et al. It has been found that there are considerable variations in the position of the CHZ. They studied around 15 human fetuses aged 16–20 weeks for the anatomical location of circle of zinn haller.

In another study by Heimann it has been said that they studied the beginning of the CHZ formation in foetuses . Some authors claimed to have outlined the CHZ on fluorescein angiography which cannot be possible in all patients due to technical reasons. In the fluorescein angiographic studies, It has been found that the various peripapillary choroidal arteries usually join together to form a peripapillary choroidal arterial arcade around the optic disc, which is located anterior to the sclera, in the choroid and the important point to be noticed is it is not situated in the sclera. So because of this reason it can be easily seen when there is an atrophy of the peripapillary retinal pigment epithelium which leads to easy visibility on studies finding the location.

To see the blood vessels which are lying deep in the scleral tissue which is opaque we cannot see the vessels by fundus fluorescein angiography studies and it is not possible. They described two types of the position of the CHZ in the sclera around the optic nerve head .

1. In Type 1- the chz was located lateral to the site of attachment of the dural sheath to the sclera in twenty eyes which constitutes aroundsixty ninety percent.

2. In Type 2 - the circle of zinn haller lies medial to the sheath which is seen in four eyes which contributes around nearly thirteen percent;

3. The circle of zinn haller was more medially located in small optic discs than a normal and large optic disc. It has been postulated that a combination of small disc, medial displacement of the circle of zinn haller , and the anatomical variation in the vascular pattern may predispose to ischemic problems of the optic nerve head.

It was also found in another study that says that there was considerable variations in the position of the circle of zinn haller in the human fetuses aged 16–20 weeks and they studied up to twenty foetuses . It was also described in another study about the beginning of the circle of zinn haller formation in fetal studies.

Some authors claimed to have outlined the circle of zinn haller on fundus fluorescein angiography . In the fluorescein angiographic studies, it was also found that there are many peripapillary choroidal arteries which usually join together to become a peripapillary choroidal arterial arcade

around the optic nerve head , situated anterior to the sclera, in the choroid and the important point to be emphasised is that it is not situated in the sclera. These vessels can be easily seen when there is atrophy and thinning of the retinal pigment epithelium around the optic nerve head.

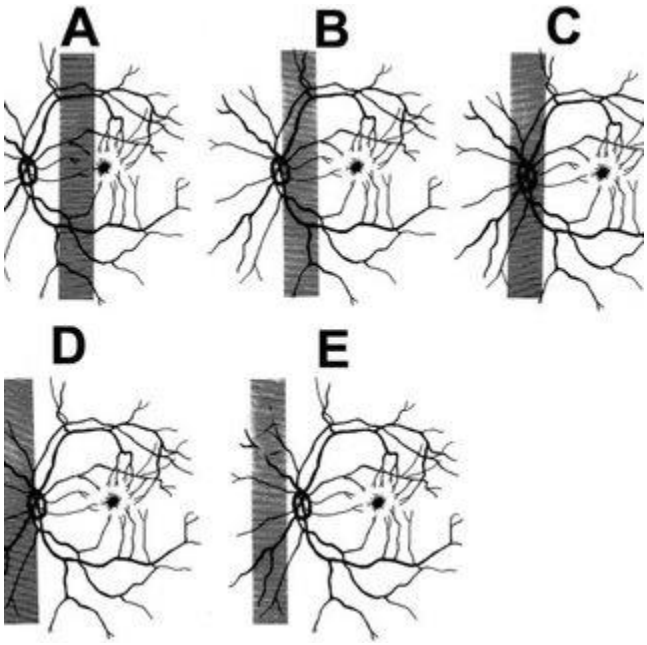
It is difficult to see the blood vessels lying deep in the scleral tissue which is opaque by fluorescein angiography .This is also applicable to the problem of visualising the circle of zinn haller on Indocyanine green angiography which is another mode of dye injecting procedure in cases of high myopia with degeneration around the optic disc.

In another study by two authors named Shimizu and Ujiie stated that in their casts of the peripapillary choroid tissue have very clearly delineated the very existence of an arterial arcade in the peripapillary choroid. They state that there were problems of seeing the circle of zinn haller on fundus fluorescein angiography or the indocyanine green angiography . They confuse the peripapillary choroidal arcade with the circle of zinn haller.

Watershed zones between the various posterior ciliary arteries and the importance of them in the blood supply and ischemic disorders of the optic nerve head :

Shortly , the definition of the watershed zone described by anatomists is that when a tissue is supplied by two or more end-arteries, the border between the territories of distribution of any two end-arteries is defined as watershed zone. The importance of the presence of watershed zones in the choroid is that in an event of a dip in the perfusion pressure in the vascular supply of one or more of the end-arteries, the so called watershed zone, which is an area of relatively poor vascularity and they are most susceptible to ischemic episodes.

All types of studies including experimental type of study and clinical types of studies have accurately said that the posterior ciliary arteries and their arteriolar branches, right down to the terminal arterioles and choriocapillaris, do have a segmental type of distribution in individuals in vivo. They also have a segmental type of distribution in the choroid as well as in the optic nerve head . Thus they conclude that there are watershed zones among the distribution of the many posterior ciliary arteries .



Suppose if we consider a situation that there are two posterior ciliary arteries - a medial and a lateral one , then the area supplied by the two in the choroid and optic nerve head shows a profound interindividual variation which further results in a wide variation in the location and site of the watershed zone.

Suppose if we consider a situation where there are three or more number of posterior ciliary arteries supplying the eye, the sites of the watershed zones vary accordingly to the number of posterior ciliary arteries, as is evident in the fluorescein fundus angiographic studies.

These locations of watershed zones are more significant in point of view of the optic nerve head because the watershed zone may pass anywhere along the optic nerve head. It can be

1.located temporal or nasal to the ONH, or

2. it may pass through one or the other part of the ONH, or

3. cover the entire ONH.

4. The watershed zone can extend vertically along the entire length of the optic nerve head and

5. can be only in the lower vertical half region or

6. Can only be in the upper vertical half , or

7. It can assume the shape of the letter ‘‘Y’’ which is easily identifiable.

The surprising fact is that in almost all types of the patterns that we have seen already, the watershed zone passes through the ONH rather than the other parts; This kind of watershed zone not sparing the ONH makes the presence of watershed zones an important thing in optic nerve head ischemic disorders. The reason is that the part of the ONH that is situated in the watershed zone is the most vulnerable part affected by ischemia, and the most vulnerable position can be when the entire ONH lies in the center part of the watershed zone which carries a significant risk for the patients.

In another study by Shimizu et al. fluorescein fundus angiography was used to study about watershed zones. Among the 172 eyes taken for study, they found filling defects between medial and lateral posterior ciliary arteries at the probable three locations:

(1) The watershed zone involves the entire optic disc and also included the temporal and nasal peripapillary regions. This was found in twenty percent of people

(ii) In the second group the watershed zone involved the temporal part of the disc . It was found in twenty seven percent of the people.

(iii) In the third group these watershed zones were randomly distributed and seen as non-fluorescent patches in a geographic pattern. This was found in fifty two percent of the sample eyes studied.

It was found in that study that there were no filling defects extending beyond the temporal peripapillary region on to the foveal region which spares the macula which is a good sign.

The type of filling defects demonstrated by them in the sites of group one and two pertains to the watershed zones in the choroidal vascular bed as we already know. They did not explain these filling defects as a part of watershed zones in the study.

It has also been reported about the prevalence and position of the choroidal watershed zones between the medial and lateral PCAs on fluorescein angiographic studies of 800 normal subjects which is quite a big study with a large number of samples. The team could not make out the borders of the watershed zone in thirty three percent of the sample eyes because of some technical problems and they couldn't visualise the watershed zone in fundus flourescein angiographic studies in twenty two percent because of the same time filling of the various posterior ciliary arteries .

Finally they could get a clear outline of the watershed zone in around forty four percent. They then made a classification according to their observation in the 44% of eyes where the watershed zone were visualised as six types. The following are the six types of watershed zones:

In the first type - the watershed zone included half of the optic nerve head and also an area of choroid nasal to the disc . They found this in three percent of individuals.

In the second type - the watershed zone involved the optic disc and the choroid nasal to the optic disc . This was found in five percent.

They classified the second type to two subdivisions.

In the first subdivision the watershed zone involves the optic nerve head and also a part of the choroid along the nasal and temporal edges of the disc . This was found in around twenty percent .

In the second subdivision the watershed zone involves the optic disc and an area of the choroid temporal to the disc which is found in twenty one percent.

In the third type the watershed zone involves the temporal half of disc and an area of the choroid temporal to the disc. This was found in around forty five percent.

In the fourth type the watershed zone involved the area between optic disc and the fovea. This was found in around five percent.

In another study by Sato et al. which was done in the year by 2000, they studied the watershed zone location by using indocyanine green angiography. In that they demonstrated the site of watershed zones in around fifty eyes who also had normal-tension type of glaucoma. In around fourteen percent , the watershed zone was not involving the optic nerve head . In around sixty percent the watershed zone partly involved the optic nerve head in ICG .In around twenty six percent the watershed zone involved the optic disc. Thirty seven percent of people had different sites of watershed zones in either eye which is unique in this study.

Regarding the visual fields of the patients , the mean of the total deviation of visual fields is greater in the eye with watershed zone which involved a larger part of the optic nerve head than in the other eye. In contrast, the eye which has the larger mean of total deviation had had a watershed region which included a major part of the optic nerve head . Finally it has been said that the site of the watershed region appears to impact the progression of the visual field defects.

In view of the above study it becomes obvious that a good understanding of the vascular supply of the optic disc and optic nerve head becomes a mandate to a good comprehension of the mechanisms responsible for the different types of ischemic diseases affecting the optic nerve head . The other thing which become obvious from the above study is that it is not the other vessels but only the posterior ciliary arteries contribution to the circulation in the optic disc and optic nerve head becomes important in the different ischemic diseases of the optic nerve head .

Variation among the individuals in the arterial supply of the optic nerve head :

It is common among the ophthalmologists to have a general opinion that the type and pattern of vascular supply of the optic nerve head is almost similar in all the eyes, and it is therefore assumed that all most all the

ischemic disorders of the optic nerve head can be explained by the one common and mostly described arterial supply pattern. Some of the studies which evaluated many facets of the vascular pattern of the optic nerve head have explored that there are enormous changes among individuals in the vascular supply pattern of the optic nerve head and optic disc .

We can contribute some reasons for those general and common opinions or ideas . One among those ideas is regarding the situation of the PCA watershed region pertaining to the optic nerve head , which we have seen in the above discussion. Few reasons are discussed in the forthcoming sections on posterior ciliary arteries.There has been a study which studied the anatomical pattern in one hundred human specimens and no two specimens had identical patterns, not even the two eyes of the same person. This variation among the individuals and among the eyes of the same patient imparts some significant implications both from the experimental and clinical aspects and this helps in detailing the difference of opinions on the subject matters. To explain to some extent regarding clinical variations, the occlusion of the same posterior ciliary artery can give rise to enormously differing patterns and about the clinical features of the ischemic diseases of the optic nerve head . Therefore , it will not be prudent to explain various types of optic nerve head ischemic diseases on the one common most described blood supply pattern.

Difference of opinions in the vascular supply of the optic nerve head :

The studies and the text regarding the vascular supply of the optic nerve head has got many difference of opinions in the past century as there were more studies with different findings . This further led to difference of opinions in the pattern of vascular supply of the optic nerve head among various anatomists and also on the different aspects of the optic nerve head ischemic diseases and also on how are those things to be interpreted . Taking all these things into consideration it is important to differentiate misconceptions from the truth in few of the most sought out details on the optic nerve head vascular supply and pattern and also in the ways and techniques to look for optic nerve head circulation clinically. In short the forthcoming points are the significant parts of difference of opinions and also the factors for those difference of opinions .

There are many studies which explain that the peri- papillary choriocapillaries supply the prelaminar part of the ONH and this is supported by the most convincing pictures from the fundus fluorescein angiographic studies . But the studies done purely on the post-mortem specimens dey this and they are completely macroscopic and microscopic morphological studies.

It is intriguing that some studies said that the peripapillary choriocapillaris was not supplying the prelaminar part of the optic nerve

head . In a paper they said that the peripapillary choriocapillaris supplies preliminar region by many small centripetal arteries .There are also some authors who concluded that few branches of the circle of zinn and haler and some branches of the short posterior ciliary arteries pass through the region of choroid and finally supplies the prelaminar part of the optic nerve head .

Contribution of Circle of zinn haller in the vascular supply of optic nerve head :

Many researchers have described about the existence and prevalence of circle of zinn haller in their studies. They also described their role in the vascular supply of the optic nerve head.

There are many studies which describe the axial blood supply of the optic nerve head. The few authors who have published some good reasearch articles are Francois and neetens

It has been concluded that the ‘‘central artery of the optic nerve’’ an ophthalmic arteries‘ branch , forms the axial blood system. In this the central retinal artery doesn’t play any significant role in the vascular supply of the optic nerve head. It has been mentioned that the central artery of the optic nerves anterior branch supply center part of the anterior portion of

the optic nerve and further it remains the main source of blood supply to the optic nerve head .

From their studies they clearly say that there is definitely an existence of the central artery of the optic nerve and that is an important part of the blood supply of the optic nerve head .But many prominent authors as hayreh, Singh, dass do not believe in the existence of such an artery after doing careful and extensive researches. The controversy has come to an end after the author Francois himself disapproved the existence of the central artery of optic nerve after doing careful collaborative researches with other researchers.

Some other authors also tried to prove the existence of such an artery. For example an author called Lieberman tried to prove the presence of such an artery but the efforts went in vain. They couldn't prove the existence of such an artery even after meticulously done researches.

Lieberman et al. did a wrong interpretation that these central retinal artery branches in their histological study. In the histological studies done with liquid neoprene latex , the branches of central retinal artery were found to be one to eight in number which is found within while traversing within the optic nerve in around seventy five percent of the eye specimens.

Distribution of the ONH blood supply is sectoral as proved by many studies. Some authors including Lieberman had their studies based only on histology of the tissues rather than invivo studies.It said that there is no such existence of sectoral distribution of vascular supply in the optic nerve head as there was a non interrupted capillary network . There is a strong emphasis on the fact that the in vivo circulation has capillaries which won't behave as collaterals in the happening of occlusion of their feeding artery/ arteriole. This can be explained by the fact of development of retinal cotton-wool spots (inner retinal ischemic spots) . This develops in spite of a continuous retinal capillary network but occlusion of a terminal retinal arteriole produces a focal retinal infarct in an area.

The most important experimental and clinical study uses the fluorescein fundus angiography as a technique to demonstrate the fact of sectorial nature of the vascular supply in the optic nerve head again and again. Here comes the importance of fundus flourescein angiographic studies which describe the in vivo nature of the blood supply.

In a similar way, ischemic diseases of the optic nerve head usually have a sectorial distribution. This is explained by studies of hayreh in AION which gives definite proof of the sectoral nature of vascular supply in the optic nerve head .

Misconceptions In the Watershed zones of the optic nerve head :

As seen in the above discussions, the existence of watershed areas among the distribution of different PCAs is a well known fact. Some speculations have erupted from many authors in various times regarding the existence of other types of watershed area in the optic nerve head . This can be explained with the example of two authors named Rootman and Butler who said about the existence of a watershed area in the retrolaminar portion of the optic nerve head . There were studies at the end of twentieth century regarding the existence of watershed area between the retinal and PCA circulation in the prelaminar part of the optic nerve head. There were speculations without any evidence of existence of such pattern.

Different investigative techniques to evaluate ONH blood supply - a reason for difference of opinions:

There are some reasons for the difference of opinions among different studies . One is that various investigators have used various techniques to evaluate the subject without even knowing their limitations. Various techniques give various kinds of information on the vascular network.

For many years there have been lot of information on the vascular supply and circulation of the optic nerve head have emerged by using different kinds of techniques which includes anatomical kind of studies using postmortem specimen casts, histological kind of studies which uses serial cut sections of the specimens obtained and further reconstruction of the anterior part of the optic nerve, and also fundus fluorescein angiographic studies which is an invivo study used to be done in ocular and optic nerve head blood supply studies in which rhesus monkeys were used and also utilised in the clinical kind of studies which deals with the optic nerve head , retinal and choroidal vascular diseases, which will be discussed further.

As there are significant variations among individuals in the vascular supply pattern of the optic nerve head , experiments done on a limited number of samples usually give a skewed data, which depends upon the type of investigation which was used and what were the patterns found out in those minimal specimens with those kind of techniques that makes every researcher believe that the specific pattern they explained was right that they may well be seen within those limitations.

Every anatomist and researcher found something peculiar but no one could explain the whole thing. The studies which are multifaceted and which has taken large number of samples and also which uses some

different kinds of technique, comprising both in vivo clinical studies and also experimental researches, may lead to a comprehensive and comprehensible account.

Semantics can lead to some confusions.)some authors have said that and also stressed that the peripapillary choroid will not in anyway contribute to the prelaminar portion of the optic nerve head blood supply ; still, they have mentioned that there are few branches of the CHZ and of the short posterior ciliary arteries pass through the choroid and finally supply the prelaminar portion of the optic nerve head ;

If the branches are present in the peripapillary choroid, then they will become a part of the peripapillary choroid itself rather than the other way. If we see through semantic side of view, if short and long PCAs and branches of CHZ have entered the sclera, then those arteries and their tributaries are a part of the choroid and would not become a part of the posterior ciliary arteries any more. So semantics can be as much confusing as much possible.

Extrapolation from the morphological studies of the post-mortem specimens to the in vivo vascular supply pattern in the optic nerve head :

In vivo studies are less compared to the morphological studies on the vascular supply of the optic nerve head in the literature . It can also be an important cause of confusion and difference of opinions .

This can be explained with an example of postmortem neoprene latex cast studies on the posterior ciliary arteries and the choroidal vascular network which misguided the researchers badly into the belief of the presence of a freely communicating vascular network ; But in in vivo fundus fluorescein angiographic studies reported that this is not the case at all, and found that the posterior ciliary arteries do have a strict sectorial distribution in the choroid and the optic nerve head and also depicted that the ciliary vascular network was an end- arterial system in the eye.

This data becomes highly important to the vascular supply in the ONH as because the posterior ciliary arteries and the peripapillary choroid are the prime source of the arterial supply. Interesting scanning electron microscopic images of ONH specimen casts explored over many years recently mostly misguided even though they have a fascinating appearance, and had the additional difficulties caused by the paucity of informations regarding the accurate orientation of the casts to the eye's soft tissues.

The important cause for the differences between the postmortem morphologic studies and their patterns and the in vivo study patterns by angiographic studies was that when the cast material was injected under pressure , the vessels get filled from all possible sources and in all possible directions, however may be the usual blood flow pattern; Therefore it must be bear in mind that the casts can only provide data regarding the morphological conduits only, while the studies done in vivo, with fundus fluorescein angiography as an indicator for the blood flow, exposes the original pattern of the vascular flow in these vessels.

Another reason is that the choroidal vascular network has an enormous nerve supply,and due to that it becomes feasible that in the alive eye the usual neural influence on the important anastomotic vessels which is evident on the postmortem injection studies and so they affect the method of vascular flow.The most important clinical consideration is that , it can be explained by the various vascular diseases , by the in vivo blood circulatory pattern and cannot be explained by the postmortem cast studies.

We can always expect a difference between the in vivo and post-mortem cast evaluation of the optic nerve head blood supply and the choroidal arterial bed circulation. The other mode of study is the Histopathological studies which are even more frightening with the issues

and can provide misguiding data regarding the supply pattern and vascular flow in the ONH. From this we need to understand that caution must be exercised when attempting to make understandings about the physiological optic nerve head vascular flow entirely from the postmortem cast and the anatomic studies.

Miscellaneous causes can be the

Confusion created by the discrepancy in the

Understanding and can also be by the unconscious personal bias made by the observer.

ISCHEMIC DISEASES OF THE OPTIC NERVE HEAD :

In the above discussions we have seen that the PCA circulation is the important source of vascular supply of the optic nerve nerve head. There is an entity called Anterior ischemic optic neuropathy (AION), an ischemic disease of the optic nerve head , is completely due to the nonperfusion or hypoperfusion of the ciliary artery circulation in the optic nerve head , and it is not because of the central retinal artery supply in the optic nerve head .

In another condition called the glaucomatous optic atrophy, there were enormous evidence of involvement of the PCA circulation alone in the optic nerve head and not the central retinal artery circulation. Few

authors like Zhao and Cioffi , on evaluating the microvascular corrosion casts of the anterior optic nerve head in almost eleven human glaucoma affected eyes, found microvascular changes in almost all eyes with further visual function loss.

There were data regarding the areas of capillary filling defects seen within the parts of the anterior optic nerve head and a reduced number of feeding arterioles to that region, losing the typical capillary patterns in the prelaminar region and the laminar regions of the optic nerve head , and there were avascular regions in the juxtapapillary choroidal bed and purely choroidal and retinal vascular network . They finally came to a conclusion that the microvascular differences seen in the anterior optic nerve head portion implies that ischemic changes can be associated with the emergence of glaucomatous optic neuropathy and they may play an important role in the progression of glaucomatous optic neuropathy.

TECHNIQUES OF EVALUATION OF THE IN VIVO VASCULAR FLOW IN THE OPTIC NERVE HEAD :

There are emerging significance of optic nerve head circulation pattern in the pathogenesis of glaucomatous and anterior ischemic optic neuropathy as they are the common blinding diseases. There are significant interest in the measurement also. There are many reviews regarding the different techniques seen in the literature to assess the optic

nerve head circulation, and its limitations .The rationale can be shortly seen and the validity and reliability of the usually used techniques are discussed below.

Color Doppler imaging:

A huge number of studies assessing the role played by the ONH circulation in the pathogenesis of glaucomatous optic atrophy have used this colour Doppler imaging. Even then , there are a few number of difficulties encountered with this type in assessing the vascular flow in the optic nerve head , which are discussed below.

What does the colour Doppler imaging measures is explained by the fact that they measure the velocity of the blood flow and the vascular resistance index in the intraorbital arteries ;But , if we do not know the diameter of the lumen of the arteries supplying the optic nerve head , then those two parameters will not essentially give any data regarding the ONH vascular flow. We all know that suppose the lumen of a tube is reduced , that will increase the velocity of the blood flow but reduces the volume of the blood flow.

Colour Doppler imaging can not provide data regarding the lumen of the artery being measured. Though some studies say that this method can measure the blood flow in the optic nerve head it is not so.

There are evidence from the study that that the prime source of blood supply to the optic nerve head is from the posterior ciliary artery circulation has misguided many researchers in this field to believe strongly that a simple evaluation of the vascular flow in the posterior ciliary arteries automatically gives data regarding the ONH blood supply. The fact is that in the large number of cases, it is not so. For the proper understanding of the reasons we have to discuss few fundamental points regarding the PCAs, which are explained further.

Posterior ciliary arteries- their terminologies and their implications:

The researchers in this ophthalmic speciality have included the term ‘‘PCA’’ as a common term while describing in their studies including all kinds of PCAs and their so called branches. This seems to be especially misguiding to the readers. The Primary posterior ciliary arteries develop from the ophthalmic artery. There were anatomical studies in the human , which described that the ophthalmic artery has given out one to five PCAs which is seen in a range from two percent to forty eight percent in various studies. It has been said that two or three posterior ciliary arteries supply an entire eyeball . These posterior ciliary arteries

commonly gets into the eyeball medially and laterally to the optic nerve head and therefore they are called as medial PCAs which are one in number in seventy one percent and lateral PCAs which are one in seventy five percent and two in twenty percent, three in two percent and none in three percent. There are also small and inconstant posterior ciliary arteries which are superior in position and are found in nine percent and they are one in number in seven percent and two in number in two percent . These posterior ciliary arteries divide into many branches before getting into the eyebal and their names are discussed below.

(1) First one is the **Long PCAs** and there're two long PCAs seen on the medial aspect and another one found on the lateral side . They primarily supply a part of the iris, ciliary body and the peripheral choroid on the medial side and the lateral side respectively, and therefore doesn't have any role in the optic nerve head blood supply .

(2) second one is the **Short PCAs** which are twenty in number or around that. They are again divided into two subgroups like the following :

(a) the first subdivision is the Paraoptic SPCAs which are a few number of SPCAs that get into the eyeball dey close to the optic nerve head . Most of the available studies says that the

ONH is probably supplied the most by the paraoptic short PCAs.

(b) the second subdivision is the Distal SPCAs which forms the bulk of the short PCAs and they get into the eyeball halfway between the paraoptic SPCAs and long PCAs . They are the main suppliers of the choroid.

From the above points it becomes sure that there are one to five PCAs and followed by three sets of branches of the PCAs which supply the three different areas and finally the paraoptic SPCAs, which enter to the ONH, constitutes only a small proportion of the whole vascular supply by the posterior ciliary arteries .

The main interesting thing is evaluating the blood flow in the paraoptic SPCAs which supply the ONH. It is extremely not possible for the Color Doppler study to differentiate between the individual paraoptic SPCAs from the distal SPCAs and long PCA as all of them are present combined and they are mingled as a single vascular bundle.

Studies confirm the In vivo sectoral supply of the choroid and optic nerve head by the posterior ciliary arteries:

Though blood supply by multiple branches seem to a favourable things for the tissues to get perfused , it cannot be taken in such a way in the eye especially the choroidal supply which supplies both the choroid

and the optic nerve head and this results in the origination of the watershed zone and the location of which part of tissue in the watershed zone as this will get most affected in the ischemia. There have been multiple studies which proved the sectorial and segmental nature of blood supply to the choroid and the optic nerve head by the posterior ciliary arteries circulation. We need to know the following two crucial points in assessing the optic nerve head flow :

First one is that variation among the individuals in the regions supplied by the posterior ciliary artery branches in the optic nerve head . There are two important branches which are the medial and the lateral posterior ciliary arteries and usually these can be the only branches which determine the watershed zone of the choroid and the optic nerve head . But this cannot be taken as a dictum that there would be only two branches and only one watershed zone as there can be many branches and many watershed zones and the location is not constant in all the individuals which is most important.

This branch, the medial posterior ciliary artery can feed the whole choroid nasally up to the part of fovea, which will include the whole optic nerve head and the variation can be it can stop its supply up to the nasal peripapillary choroid alone and therefore that it cannot contribute to the

blood supply of the optic nerve head . There can be many number of variations among these two possibilities .

The other branch which is the lateral posterior ciliary artery which supply the region of the choroid and the optic nerve head which are not supplied by the medial posterior ciliary artery if there are only two branches in that matter. The most challenging situation is when there are more than one medial or lateral posterior ciliary arteries and the region supplied by them may be extremely varying. If there is a presence of a branch called as superior posterior ciliary artery the then it would supply the superior part according to the name.

Hence the researchers conclude that the pattern of supply of posterior ciliary arteries and their distribution , their number of branches which supply the choroid and the optic nerve head vary widely and it should be bear in mind while evaluating the of ischemic diseases of the optic nerve head .

The second thing is that the watershed area created by the widely varying distribution of the posterior ciliary arteries and their location with respect to the optic nerve head is more important while evaluating the ischemic disorders of the optic nerve head

These things were shortly explained in the above discussions and this can be seen in detail in the figures accompanying these texts. These watershed zones will determine the fate of optic nerve head and their further predisposition to the ischemic disorders such as anterior ischemic optic neuropathy and glaucomatous optic neuropathy as their presence in the watershed zone would determine that.

Another most important fact is that in the occurrence of a decrease in the perfusion pressure of the posterior ciliary artery circulation, that region of the optic nerve head which is situated in the watershed area will become the prey for ischemic episodes.

Regarding the studies which can give some valuable information regarding the optic nerve head blood flow in vivo , there are no perfect studies which do that except for the flourescein angiographic studies but it cannot be done in all due to its limitations. The other kind of investigations such as Color Doppler imaging and others do not give useful data regarding the portion supplied by the various branches of the posterior ciliary artery in the optic nerve head. They do not give useful information about the watershed zone also.

Fluorescein fundus angiographic study - the most important study for evaluating the invivo pattern of optic nerve head blood flow :

There were many researchers , anatomists and scientists who from the middle of the twentieth century started evaluating the role of fluorescein fundus angiographic studies in obtaining the details regarding the optic nerve head flow pattern. This should **be bear in mind that because of the arrival of the angiographic studies especially the flourescein angiographic studies we could get the invivo pattern of blood flow and details about the watershed zones involving the optic nerve head.** But the negative part is that, the fluorescein angiographic studies have many limitations due to the side effects though it is rare, the assessment of optic nerve head blood flow cannot be done in all subjects.

Now the question arises of which method can be employed for obtaining the best results in getting almost all details of optic nerve head flow pattern in both normal and diseased optic nerve head ,we need to know about the two kinds of angiography known as very rapid sequence angiography and the second one video angiography which can be two prudent methods of obtaining sufficient valuable data . We need to know the phases of angiography and their implications in assessing the optic nerve head flow pattern. As the choroidal phase only shows up the the ciliary circulation in the optic nerve head , we have to get the choroidal or

pre retinal pictures which will give the flow pattern as the next phase which is the retinal phase involves the central retinal artery which has no role in the optic nerve head blood supply.

In the retinal phase the surface capillary layer of the optic disc gets filled up and it would completely mask the underlying choroidal supply of the optic nerve head. And because of that , no valuable data could be obtained after the choroidal phase or in the retinal phase as all these would give information about the superficial layers than the much needed deeper capillary layer of the optic nerve head.

The exception to these are the two conditions where there will be either no filling or delayed filling and they are CRAO and conditions like retinitis pigmentosa.

In the first condition CRAO , there will be no filling of the surface nerve fiber layer capillaries which are originating from the central retinal artery .

In the second condition retinitis pigmentosa , there would be delayed filling of the central retinal artery leading to prolonged choroidal or the pre-retinal arterial phase of angiography which can be visible lasts for more seconds, and it is more delayed compared to the ciliary artery circulation supplying the optic nerve head except the surface layer. Thus

we can get more time for evaluating the optic nerve head flow in these conditions.

Though fundus fluorescein angiographic studies give highly valuable information regarding the in vivo blood flow pattern of the optic nerve head , the ophthalmologist need to know the pros and cons and need to decide about the prudent application of this investigation.

Laser Doppler flowmetry:

There were many studies that have described about measuring the ONH blood flow with laser Doppler flowmetry technique. The study by Petrig et al.found that the laser Doppler flowmetry technique is mainly sensitive to the vascular flow changes in the superficial layers of the optic nerve head and thus yield very meagre data regarding the prelaminar portion and the deeper portions of the optic nerve head . Therefore it can be said that laser Doppler flowmetry which measure the ONH blood flow are invalid both in health and disease.

There are many more techniques which are used to determine the measurement of ONH blood flow from the surface portion of the optic disc.

There are techniques to measure the oxygen tension from the surface of the optic disc, by means of the oxygen microelectrodes and there are other methods, which are tried to assess the blood flow in the optic nerve head Obviously , they also suffer from the same drawbacks as laser Doppler flowmetry, which were discussed above. So it can give valid data regarding the surface layer of the optic nerve head which are supplied by the retinal arteries rather than the posterior ciliary arteries , but they did not mention regarding the deeper layers of the optic nerve head which are fed by the ciliary artery circulation.

Let us assesss the rationale behind measuring the blood flow in the choroid compared to that in the optic nerve head.

A few number of studies have evaluated the blood flow and other blood flow and vascular changes in the choroidal vascular network and they have spontaneously merged those findings to the optic nerve head circulation, as both the tissues ie. choroid and optic nerve head are been supplied by the posterior ciliary arteries . But, again, these findings regarding the circulatory pattern and other data regarding that from the choroid at large are not relevant to the optic nerve head circulation which is an important point to be considered. For us to comprehend this we need to know few fundamental facts regarding the part played by the choroid in the optic nerve head blood supply, and their association between the

choroidal and optic nerve head circulations. It can be explained with the following examples.

(1) The important fact is that even though both these tisssues i.e. optic nerve head and the choroid are being supplied by the posterior ciliary arteries , we cannot conclude the choroid has a significant in the vascular supply of the optic nerve head . The fact is that the peripapillary choroid which is relevant to the optic nerve head contributes to only a minimal portion of the whole choroid.

(b) And also, this is the specific branch of posterior ciliary arteries circulation which is the paraoptic SPCAs which supply the optic nerve head and the peripapillary choroid region (the choroid part); In opposite to that the remaining part of the choroid is exclusively supplied by the distal SPCAs, with the exception being a minimal horizontal portion of the peripheral part of choroid on the lateral part and the medial part that are supplied by the long branch of the posterior ciliary arteries .

Some facts regarding the amount of blood from the posterior ciliary artery circulation supplying the optic nerve head is a minimal portion in comparison to that in the remaining portion of the choroid, so that the optic nerve head may become ischemic even when there are not identifiable changes in the circulation of the choroid.

These findings are obviously seen in many of the fluorescein angiographic studies done in the eyes with ischemic optic neuropathy and also seen in glaucomatous optic neuropathy eyes.

We can discuss about the role of pulsatile blood flow to the eye and their role in the optic nerve head vascular supply.

Many studies have found that pulsatile blood flow pattern in the eye explains regarding the vascular flow in the optic nerve head . We need to identify the relationship between the pulsatile nature of eye blood flow to the blood flow pattern in the optic nerve head. We have to take into account some of the basic problems associated with that . Ophthalmic pulsatile flow measurements typically calculate the difference among the systolic and diastolic blood pressure in the choroidal vascular network , and it has been found out that the vascular flow in the optic nerve head and the retinal vascular network is not applicable to that in the vessels of the choroid .

This investigation can find out only the pulsatile nature of the vascular flow and they are unable to determine the other one which is the nonpulsatile ocular flow. Another point regarding this is that it is unable to make out the percentage of the total ocular vascular flow which are pulsatile and those are nonpulsatile. The main portion which contributes to the pulsatile ocular blood flow part is through the choroidal vascular

flow.We have already seen that , the choroidal vascular network with the exception being the minute peripapillary choroidal supply , this has got nil role in the vascular supply of the optic nerve head .

We at think that we can derive the calculation of total ocular blood flow in the choroidal tissue and the changes in it can give rise to the real scenario of the vascular flow in the optic nerve head . But it is not so. We are unable to derive at any such calculations from that. So it becomes obvious that this investigation doesn't give any useful data regarding the optic nerve head vascular flow. Some variations have been made in this investigation and it is called as ocular pneumoplethysmography in which the intraocular pressure is increased by using a suction cup and this investigation has also got the above said issues and is not practically useful;

It is not prudent to apply all these kind of investigations and techniques deriving information from the ophthalmic artery, central retinal artery, posterior ciliary arteries and the choroid to the optic nerve head circulation implies and give an impression of trust but it is not justified.

We will discuss about the role played by the morphological types of studies in assessing the in Vivo blood flow pattern of optic nerve head.

There arises a question whether these studies can bring out valuable data regarding the disturbances in the in vivo blood flow though it can give anatomical details of the optic nerve head blood supply. There are also issues whether it can differentiate between the morphological patterns of different types of optic nerve ischemic disorders. There are a huge amount of these kind of morphologic studies carried out on the eyeballs and they assessed the optic nerve head in both glaucoma affected eyes and nonglaucomatous eyes. The one thing which we can conclude is that these kind of studies can give valuable information regarding the morphological variations in the tissues such as the optic nerve head , but they do not convey much information regarding the in vivo blood flow pattern of the optic nerve head .To be particular , the available resources can sometimes be misguiding also.

To substantiate this if we consider a histologic study of the optic nerve head done in eyes with glaucoma , there have been reports saying that there are more number of vessels and capillaries in the optic nerve head even if they have early stage and moderate stage loss of retinal nerve fibersdue to glaucoma . This study may mislead the reader that that there is no vascular pathology in the optic nerve head in glaucomatous eyes, and the vascular derangement in the optic nerve head is not a part of optic

nerve head changes happening in the glaucomatous eyes. We need to understand two most relevant truths regarding this :

First one is that the capillaries in the optic nerve head are better resistant to the ischemic changes than the nerve cells , and The second one is that the mere appearance of the capillaries in the histologic section, doesnot necessarily mean that there was a normal blood supply and blood flow was adequate and there was presence of no ischemia. To explain this we can consider a study done on the retinal arteries and veins with the help of Indian ink and the study also included trypsin digested retinal tissues with focal regions of ischemia as evident by the macroscopic appearance of cotton wool spots ,revealed that there are retinal capillaries present in the cotton wool spot region also, but these capillaries did not get filled up with the indian ink. In the same way , the mere availability of RBCs in the capillaries on histologic evaluation doesnot warrant a normal or adequate amount of blood flow in the optic nerve head .

I conclude that there are many studies done with many types of investigations available in the ophthalmologist network regarding the optic nerve head blood flow pattern and their ischemic disorders but they show a large amount of variation among the individuals and that becomes a basic problem in extrapolating the results to the common population. Almost all kind of studies including the morphological methods discussed above have

problems and setbacks in assessing the optic nerve head blood flow. Therefore we cannot conclude a single investigation as the best to completely rely upon for determining the ocular blood flow pattern especially the ONH blood flow pattern in the humans , both in normal conditions as well as diseased conditions such as ischemic optic neuropathy and glaucoma. The importance of this availability of large number of studies is that it can be misguiding also so that we need to be careful in selecting the investigation to guide us in the interpretation of the optic nerve head circulation in both normal and diseased conditions .

Ischemia of the optic nerve head can result in various disorders like anterior ischemic optic neuropathy and glaucomatous optic neuropathy , which all combined together becomes one of the important reasons of blinding diseases or highly impaired vision in the humans . Hypertension is an important cause of ischemic optic neuropathy which can be avoided by proper treatment and also by identifying at risk patients such as those having crowded disc, risky watershed zones involving the optic nerve head, **those taking calcium channel blockers or anti hypertensives at bed time** and identifying those risk factors and proper counsel Ling and followup of the patient can help in avoiding and diagnosing ischemic optic neuropathy at early stages. Here comes the importance of fundus fluorescein angiographic studies which give the invivo optic nerve head

blood flow pattern which can be helpful in identifying the at risk patients with watershed zones involving the optic nerve head. I have chosen to do a study on this because of all these reasons.

PART II

AIMS AND OBJECTIVES

THE AIM OF THIS STUDY IS TO OBSERVE AND STUDY THE PATTERN OF OPTIC NERVE HEAD FILLING IN FUNDUS FLOURESCEIN ANGIOGRAPHY IN HYPERTENSIVE PATIENTS WITH NORMAL AND CROWDED OPTIC DISC

STUDY DESIGN: PROSPECTIVE OBSERVATIONAL STUDY

INTENDED SAMPLE SIZE: 50 patients

MATERIALS AND METHODS

Patients are to be recruited from among all those who visited ophthalmology & medicine outpatient department as well as inpatients of the ophthalmology and medicine ward of GRH Madurai between February 2019 and September 2019.

STUDY PERIOD:

8 months (February 2019 to September 2019).

SELECTION OF SUBJECTS:

A total of about 50 hypertensive patients of age 50 years and above attending eye department & medicine OPD and residing as inpatients in the ophthalmology & medicine ward of GRH, Madurai, satisfying the following inclusion and exclusion criteria are to be considered for the study.

The inclusion criteria:

1. hypertensive patients of age 50 and above
2. hypertensives > 10 years
3. Grade 1 hypertensive retinopathy

4. Grade 2 and 3 hypertensive retinopathy
5. both male and female patients
6. Essential hypertension
7. Both normal and Crowded optic disc - C:D < 0.3

The exclusion criteria:

1. associated comorbidities(diabetes)
2. collagen vascular disorders
3. giant cell arteritis
4. Secondary hypertension
5. Accelerated hypertension
6. ocular comorbidity (glaucoma)
7. Grade 4 hypertensive retinopathy
8. Optic atrophy

FINANCIAL SUPPORT: Nil

METHODOLOGY:

All subjects shall be selected only after obtaining consent for entry to the trial.

All patients shall undergo a complete ocular examination (which includes Best corrected visual acuity, slit lamp examination, fields, colour vision, tonometry by Goldmann applanation tonometer, ophthalmoscopy , a fluorescein angiography of the fundus, and stereoscopic colour fundus photographs)

Fundus fluorescein angiography shall be performed using a standard model canon fundus camera with a dual filter system (excitation filter and barrier filter)

At the start of the examination, fluorescein will be injected intravenously (as in retinal angiography). A 5 ml dose of a 20%solution of fluorescein shall be used (about 14 mg/kg body weight);

Fundus fluorescein angiography shall be performed. A standard model canon fundus camera with dual filter system (excitation and barrier filter) is to be used with imaging parameters suitable for Fundus colour photography and fundus fluorescein angiography. Fundus photographs will be evaluated.

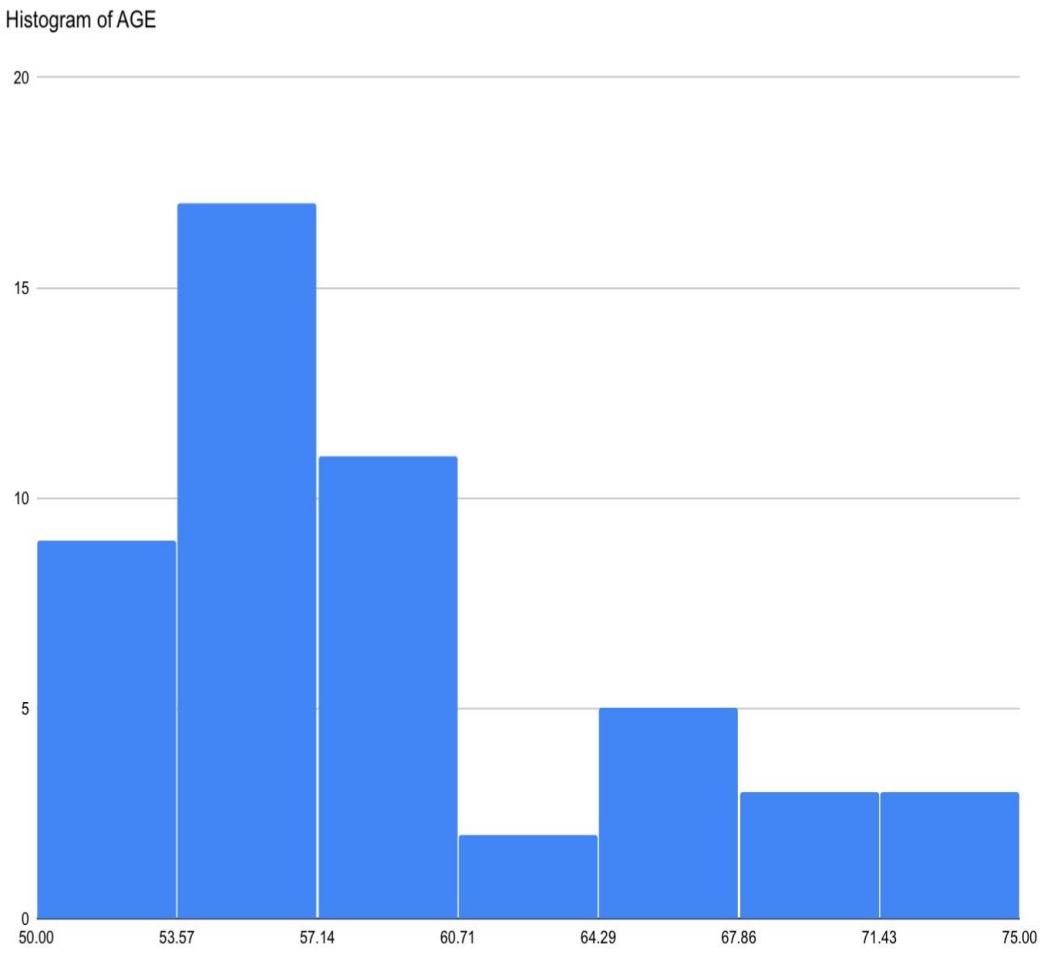
OBSERVATION AND ANALYSIS:

AGE DISTRIBUTION OF THE SAMPLE:

The average age of the sample is 58.9.

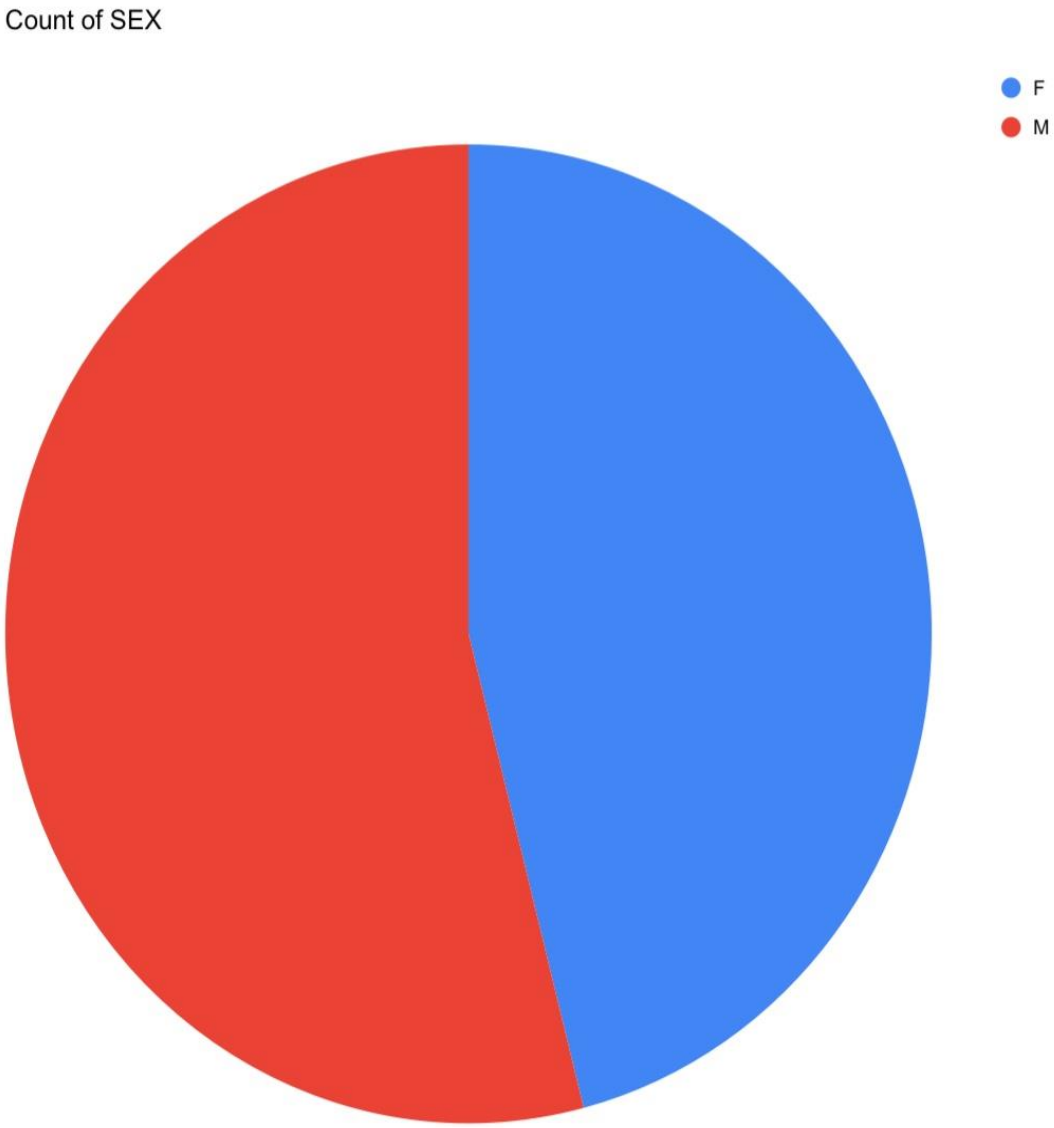
The minimum age is 51.

The maximum age is 73.



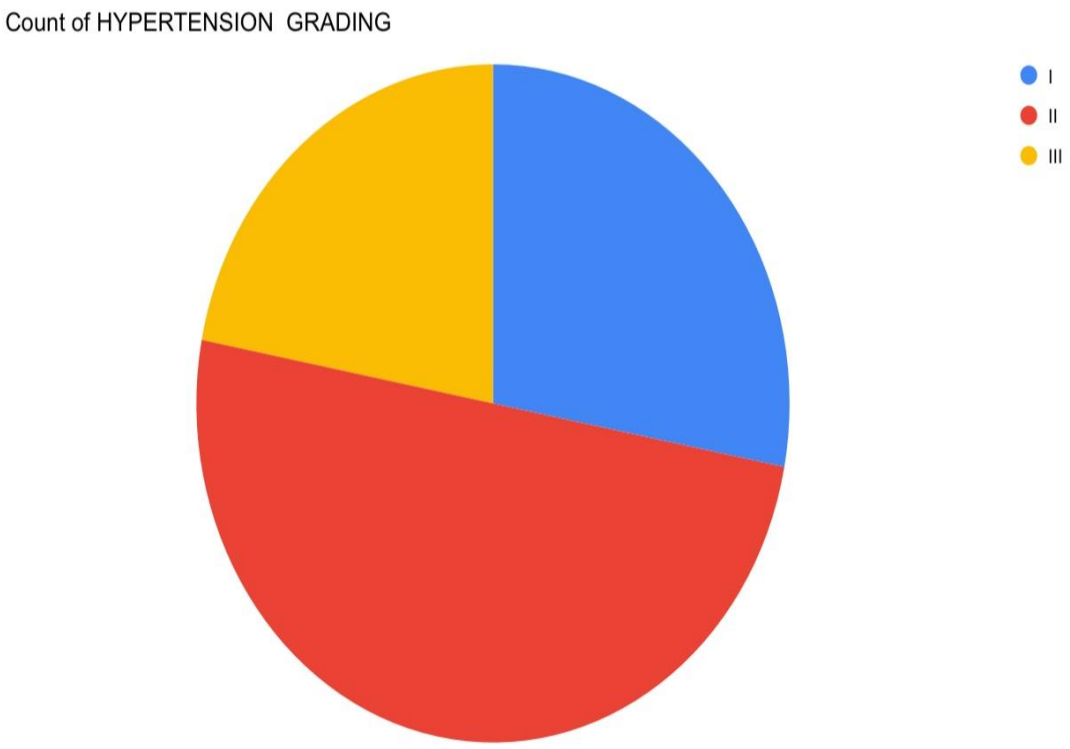
SEX DISTRIBUTION OF THE SAMPLE :

There were 27 males and 23 females in the sample.



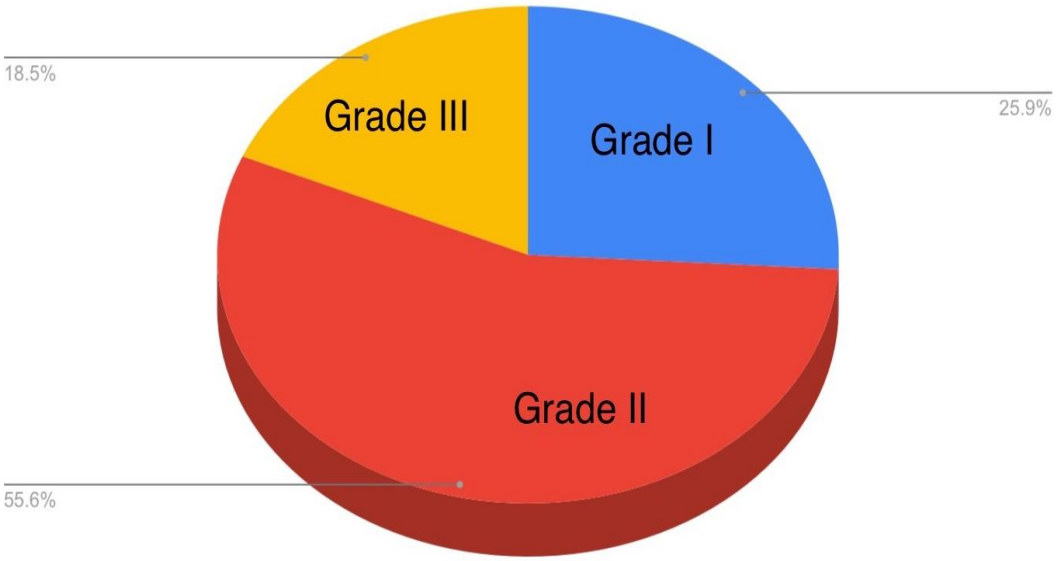
HYPERTENSIVE RETINOPATHY STAGES AMONG SAMPLE

Grades	Total	Male	Female
I	14	7	7
II	25	15	10
III	11	5	6
TOTAL	50	27	23

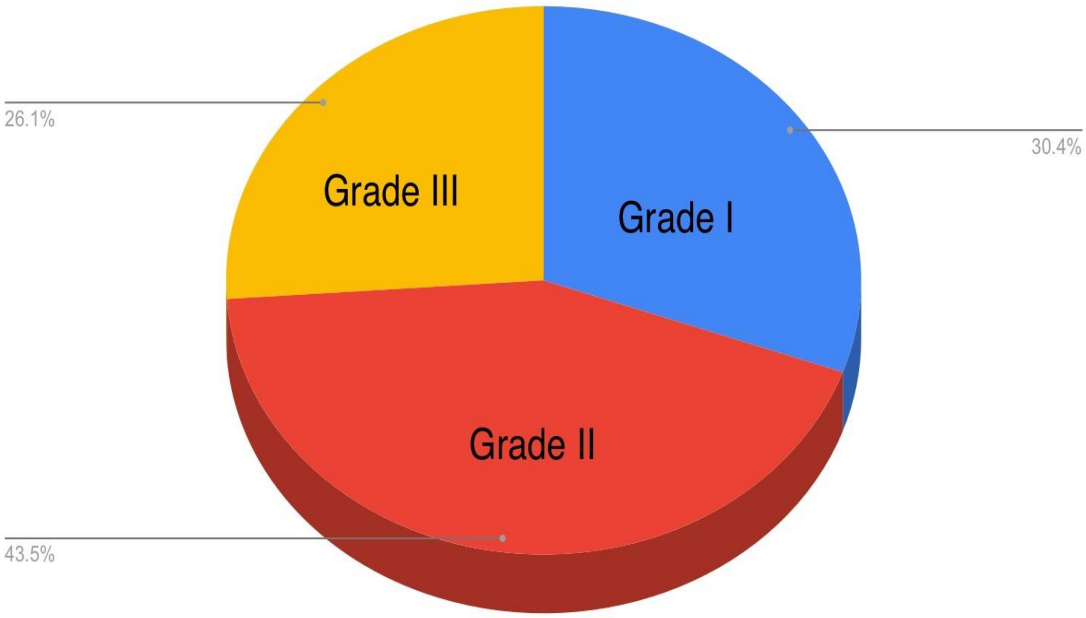


Grades of hypertensive retinopathy	Males (%)	Females (%)
I	25.9	30.4
II	55.6	43.5
III	18.5	26.1
TOTAL	100	100

MALES :

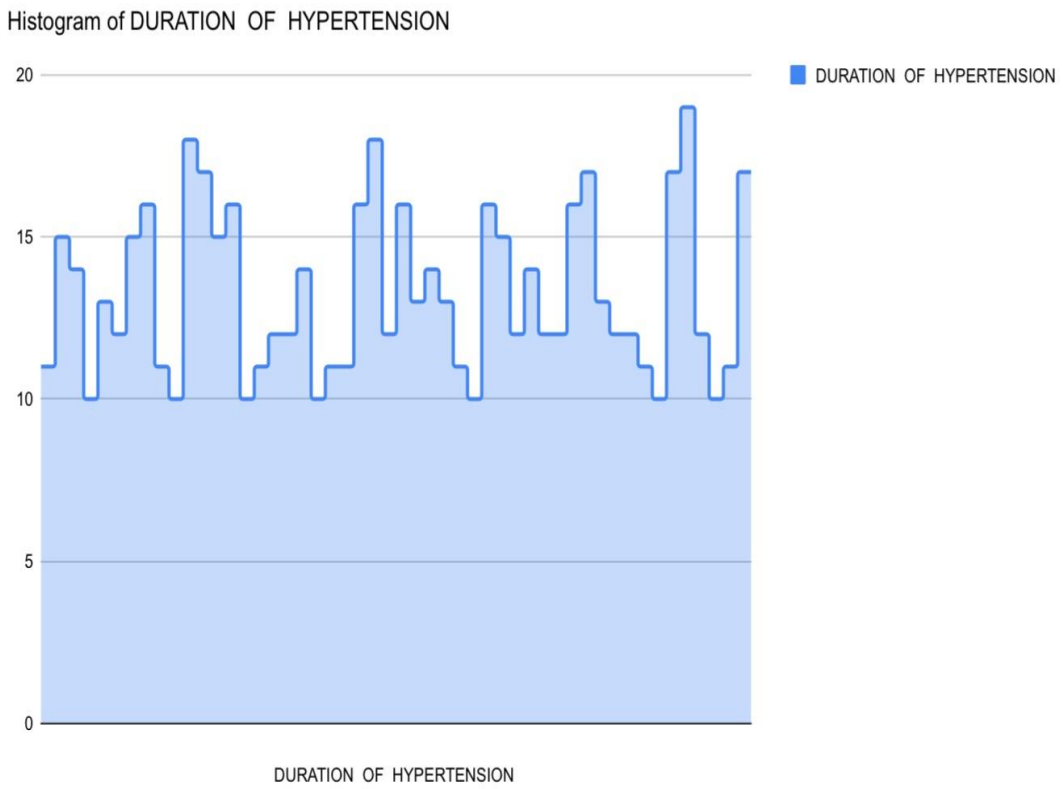


FEMALES :



DURATION OF HYPERTENSION :

SEX	MEAN DURATION (in years)
MALE	13.40
FEMALE	13.17



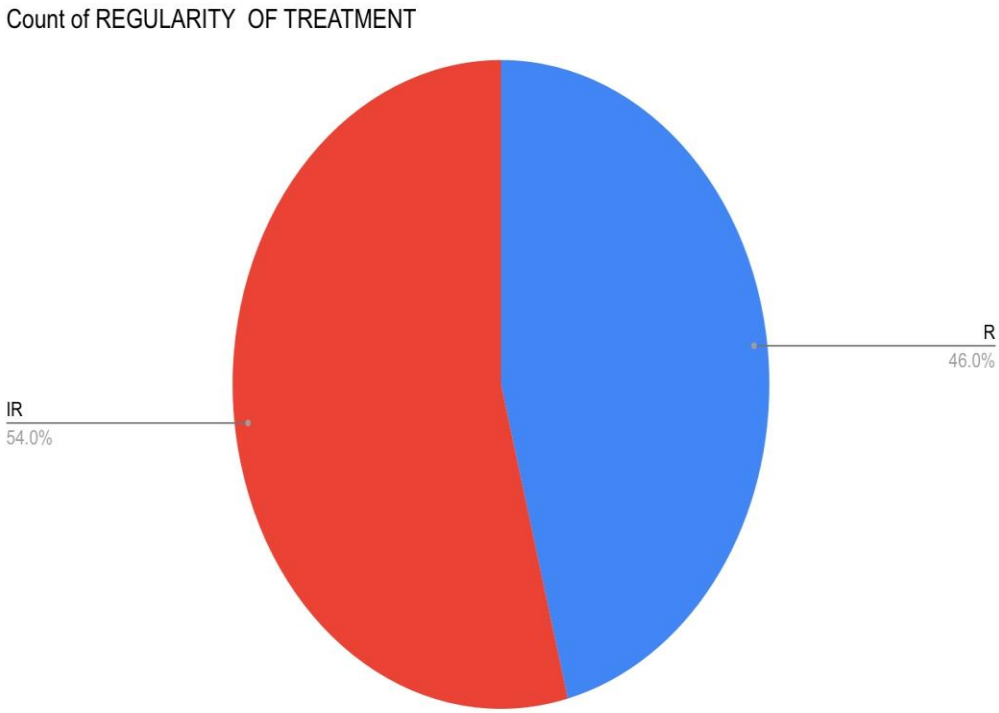
The mean of duration is 13.3 years.

Maximum duration is 19 years.

Minimum duration is 10 years.

REGULARITY OF TREATMENT:

Regularity	Male	Female	Total
Irregular	16	11	27
Regular	11	12	23
Total	27	23	50



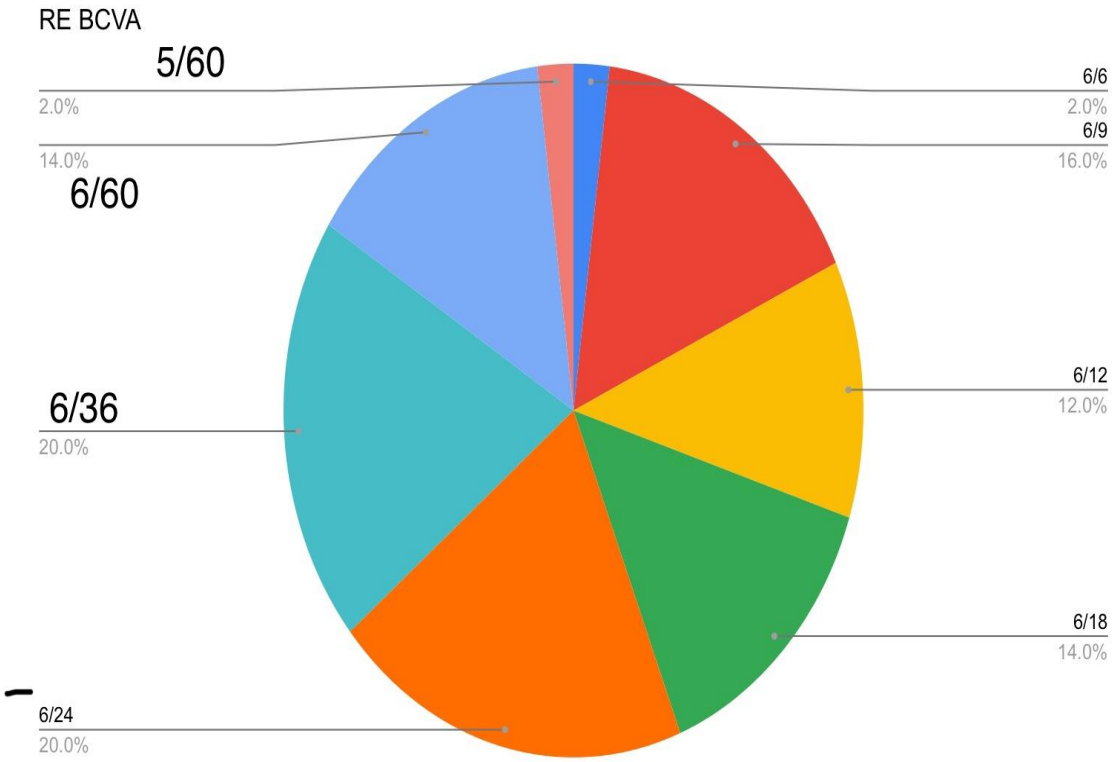
54.0% were irregular in their treatments.

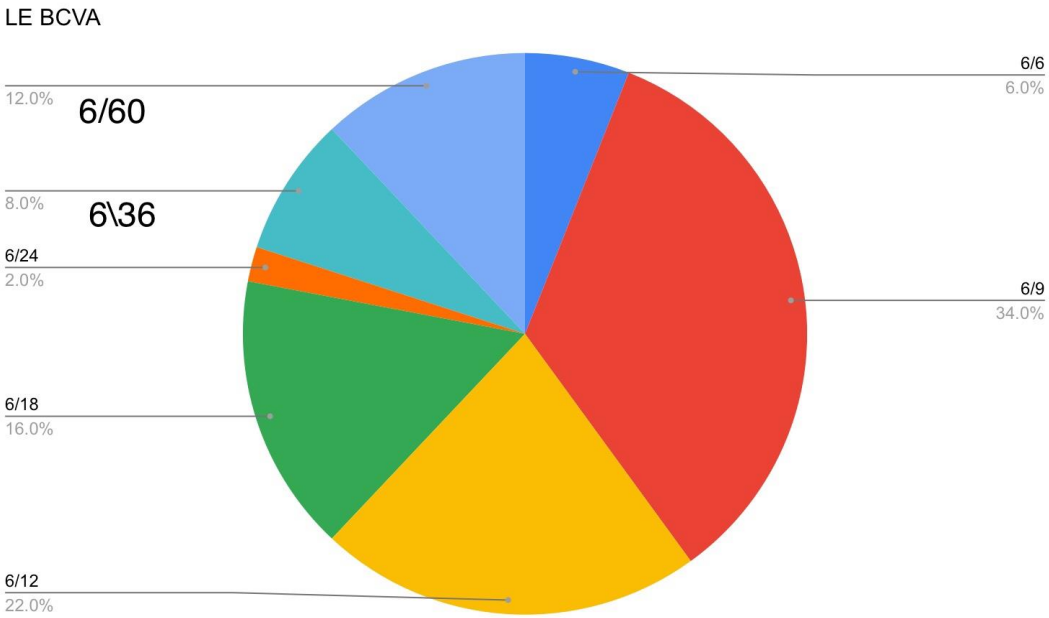
46% had regular treatment for hypertension.

Regularity	Male (%)	Female (%)
Regular	40.74	52.17
Irregular	59.25	47.82
Total	100	100

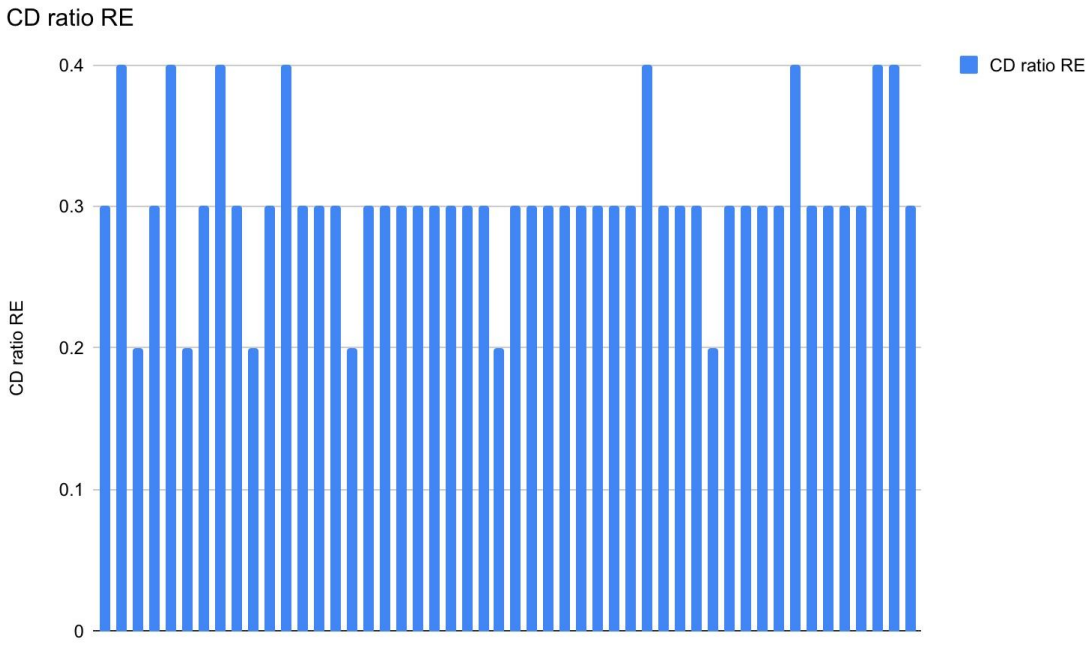
Males were more irregular than females in getting the treatment.

BCVA :




LE BCVA
6/6
6.0%
12.0%
6/60
8.0%
6\36
6/24
2.0%
6/9
34.0%
6/18
16.0%
6/12
22.0%

CD ratio :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CD ratio RE
0.4
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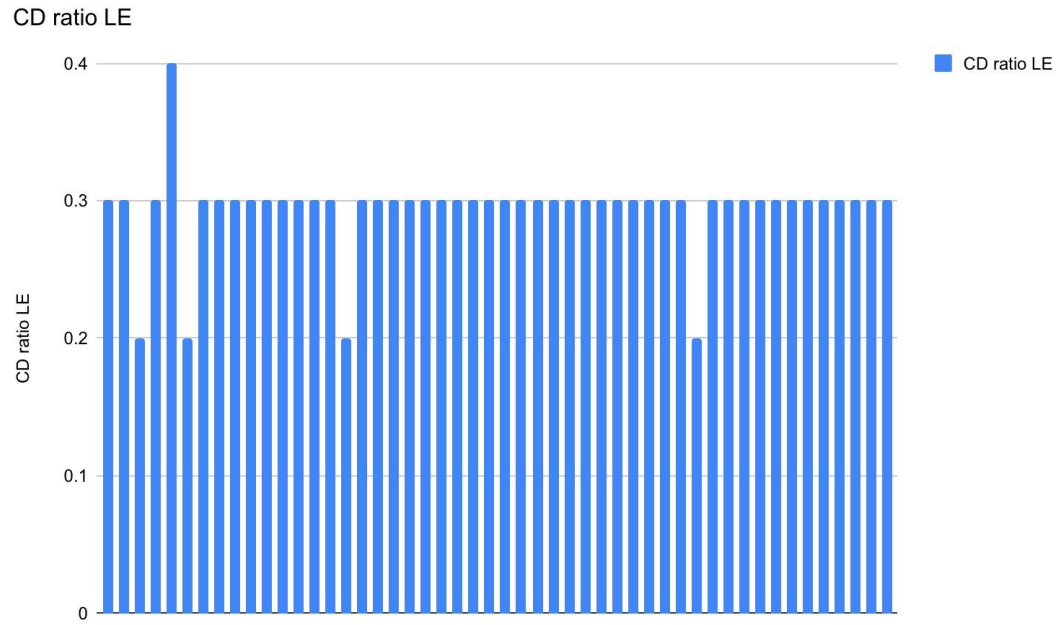
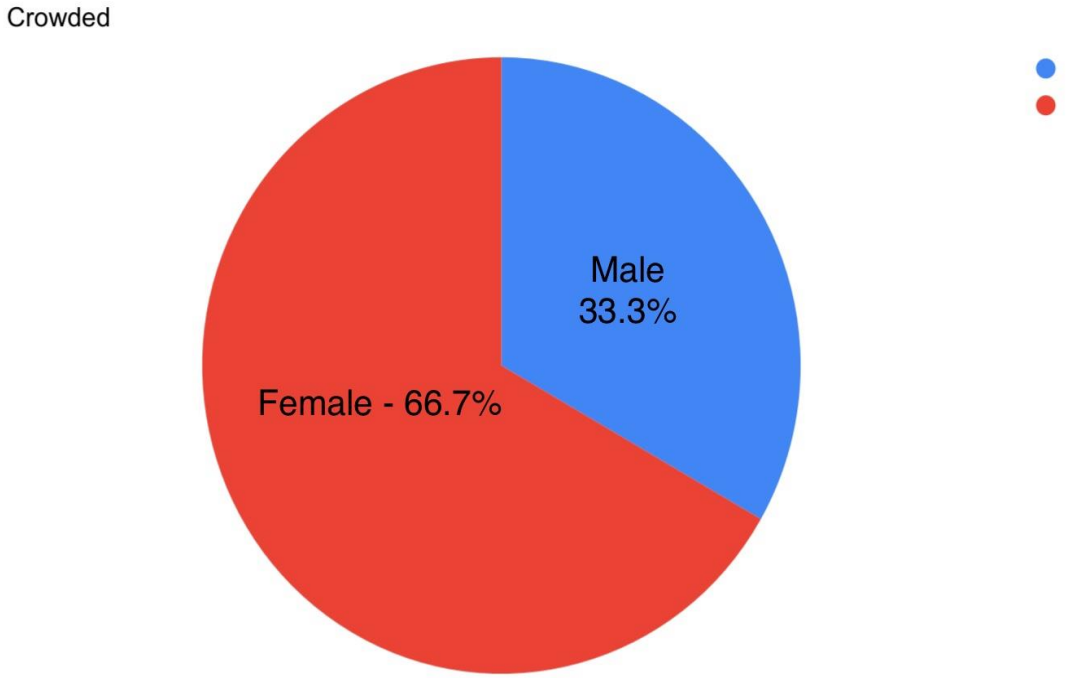
CD ratio RE



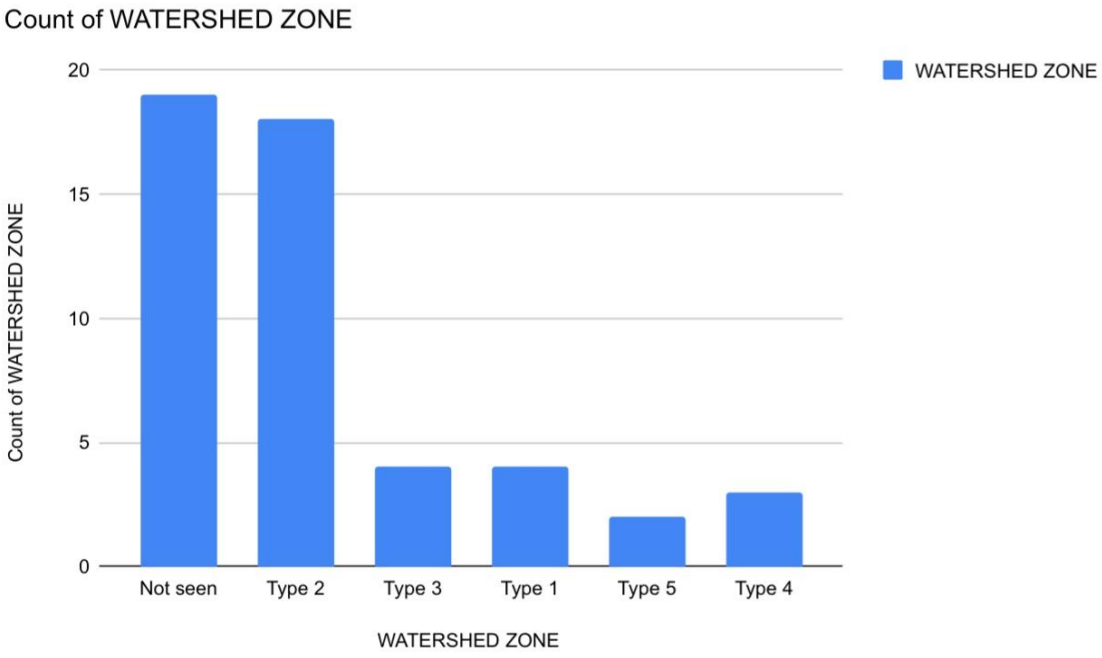
Disc	Male	Female	Total
Normal	25	19	44
Crowded	2	4	6
Total	27	23	50

CROWDED DISC:

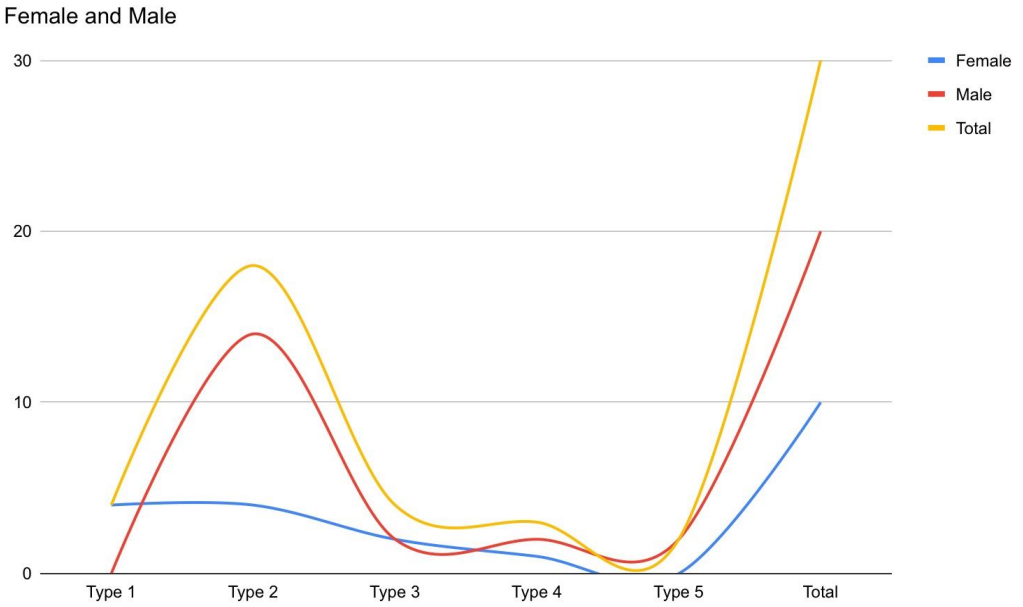
Prevalence of crowded disc among the sample . Females found to have higher percentage of crowded disc than males .

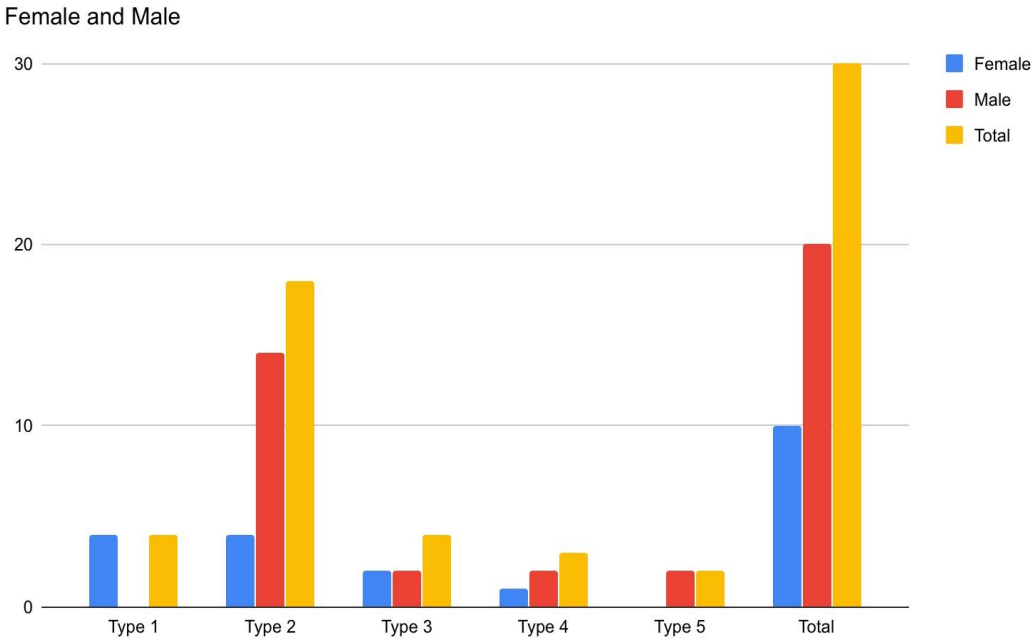


WATERSHED ZONE TYPES:



Male and Female distribution:

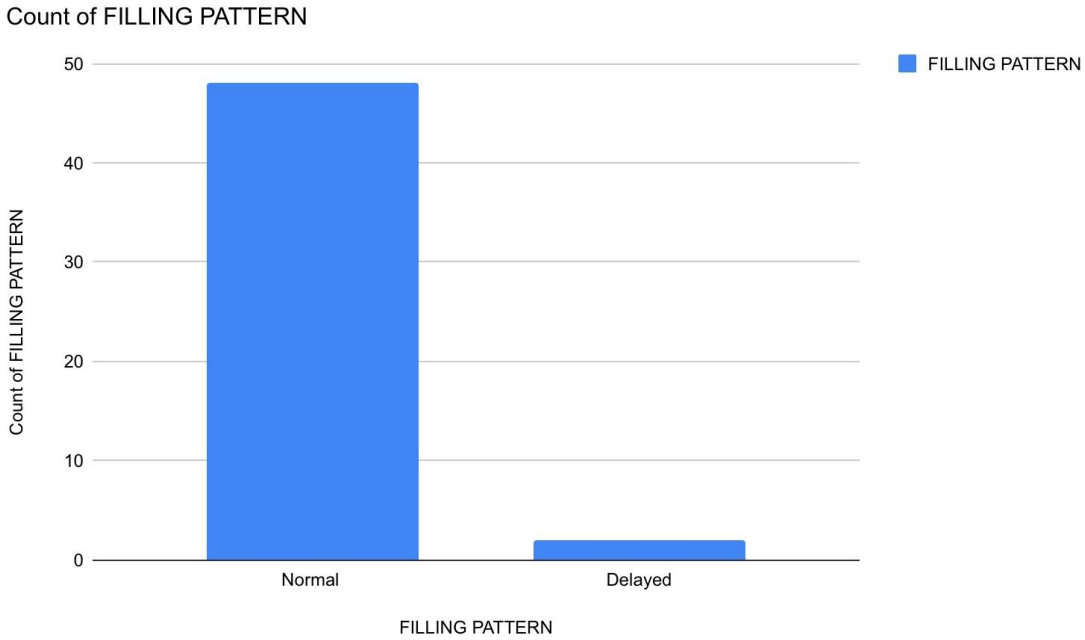




Type of Watershed zone	Male	Female	Total
Type 1	nil	4	4
Type 2	14	4	18
Type 3	2	2	4
Type 4	2	1	3
Type 5	2	nil	2
Total	20	10	30

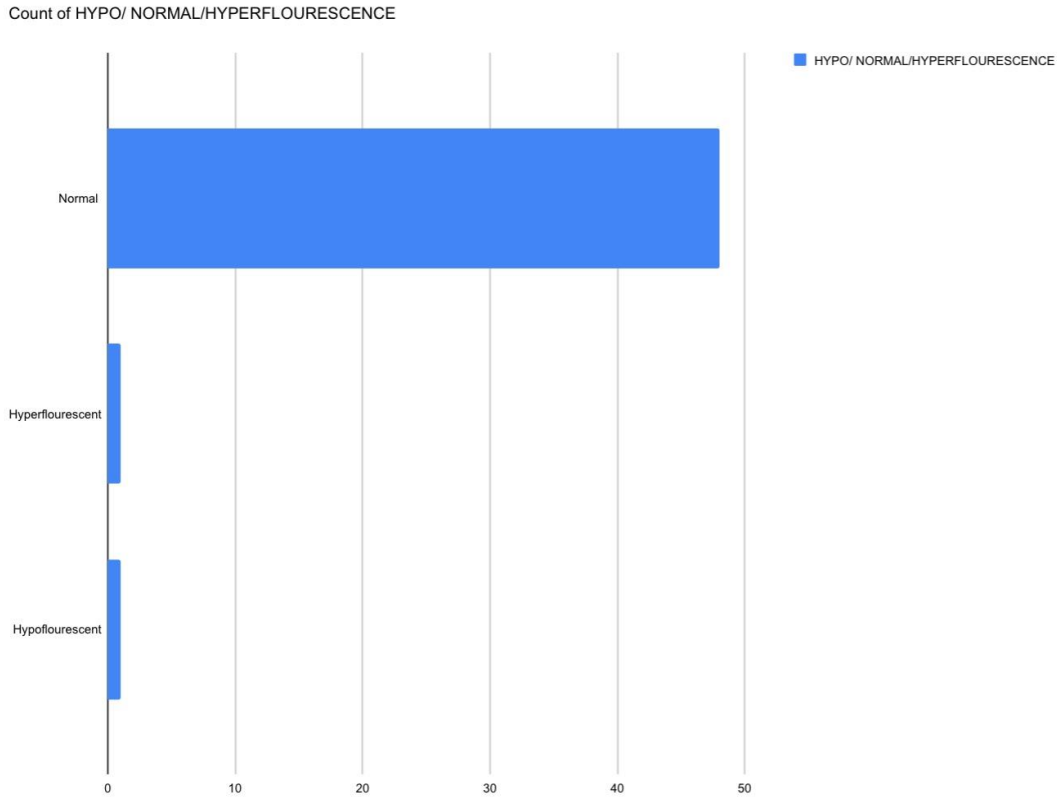
Crowded disc	Risky watershed zone	Non risky watershed zone	Watershed zone - not seen	Total
Male	1	nil	1	2
Female	1	nil	3	4
Total	2	nil	4	6

FILLING PATTERN :



Filling pattern	Male	Female	Total
Normal	25	23	48
Delayed	2	-	2
Total	27	23	50

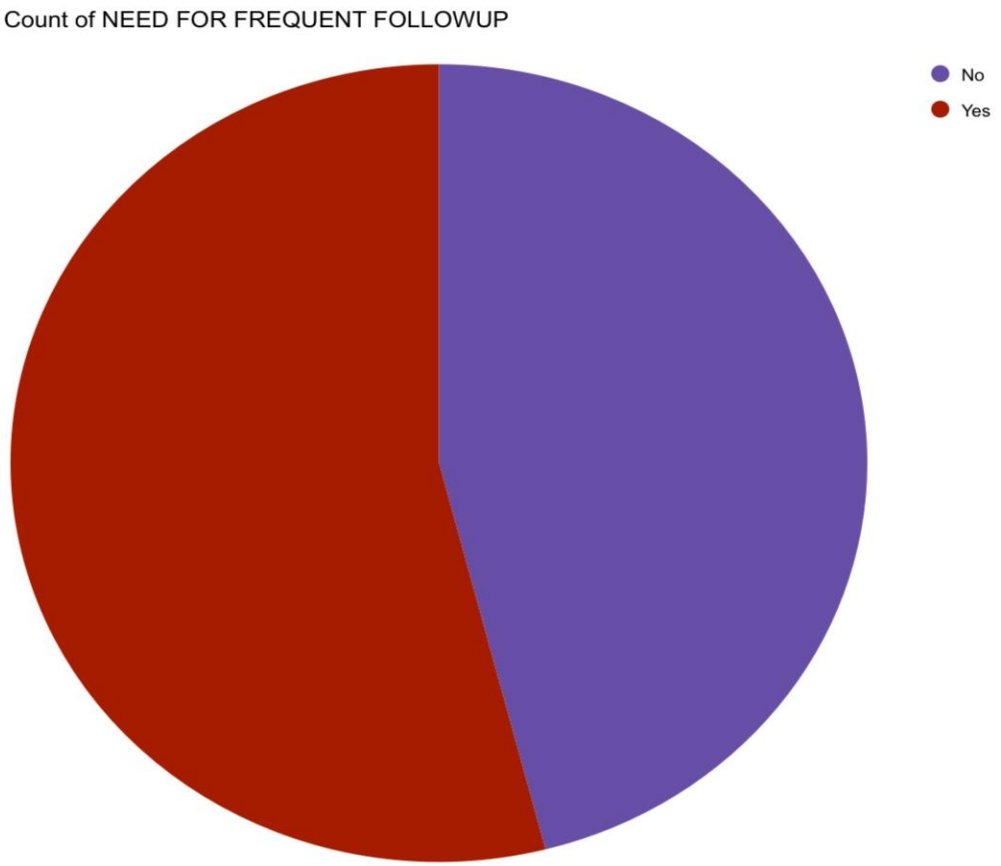
FLOURESCENCE - NORMAL / HYPO / HYPER FLOURESCENT



Flourescence	Male	Female	Total
Normal	26	22	48
Hypoflourescent	1	nil	1
Hyperflourescent	nil	1	1
Total	27	23	50

Flourescence	Disc type	Watershed zone	Duration of treatment	Regular / Irregular treatment
Hypoflourescence	normal	Type 2	10 years	Regular
Hyperflourescent	crowded	not seen	12 years	Regular

NEED FOR FREQUENT FOLLOWUP :



DISCUSSION AND ANALYSIS

In my study there were fifty people involved. The age distribution was from 51 years to 73 years. The mean age was 58.9 years. Regarding the sex distribution of the sample , it has got 27 males and 23 females . Males were slightly higher in number than the females. In this study we included all grades of hypertensive retinopathy patients except the type IV hypertensive retinopathy patients. There were 14 type I hypertensive patients and 25 type II hypertensive patients and 11 type III hypertensive patients. Among the type I 7 were male and 7 were females. Among the type II patients 15 were male and 10 were females. This constituted the higher percentage of patients among all. Among the type III there were 5 males and 6 males. Males constituted a higher percentage in type II and the females were more in the other two types.

Duration of hypertensions' cutoff was 10 years. Only those who had ten years of hypertension were included in the study. The mean duration was 13.3 years and the maximum duration was 19 years & the minimum duration was 10 years.

All of them did not get a regular treatment. 54% were irregular in taking their treatments. 46 % were regular in taking their treatments. Female s were more regular than the males in getting their treatment.

The best corrected visual acuity was ranging from 5/60 to 6/6 in right eye and in left eye it was from 6/60 to 6/6.

Cup disc ratio is an important factor pertaining to this study as crowded optic disc patients are at risk of developing hypertensive ischemic optic neuropathy. Totally there were 6 crowded optic disc patients among the sample in which 2 were male and 4 were female. Females found to have a larger proportion of crowded discs than the males in this study.

Watershed zones were assesssed by fundus flourescein angiographic studies. There are 5 different types of watershed zones and type 1 were found in 4 patients and type 2 were found in 18 patients. Type 3 were found in 4 patients , type 4 were found in 3 patients and finally type 5 were found in 2 patients. Overall type 2 was found as the most common type in this sample. Males had more of type 2 watershed zone and females had both type 1 and 2 commonly.

Filling pattern was assessed in this and delayed filling was found in 2 patients among the 50.

Hypoflourescence was found in the disc in 1 patient and hyperflourescence was found in 1 patient.

I have considered crowded disc patients, filling delay patients, hypoflourescent disc patient, those who have type 2,3,4 watershed zones

as at risk patients and thus at risk constituted more than 50% in my study and I insist more frequent and regular followup for these patients.

Statistically significant difference exists among the different groups of watershed zones, otherwise no other analysis showed statistically significant difference in the other groups.

I did statistical analysis using SAS software, using chi-square test.

SUMMARY

1. Males were more than the females in this study
2. The mean age was 58.9 years.
3. Among the three grades of hypertensive retinopathy taken in to study, type II constituted more.
4. Both in males and females type II hypertensive retinopathy was seen more.
5. The mean duration of hypertension was 13.3 years.
6. Males had slightly higher mean duration than females.
7. Females were more regular in getting their treatment than the females but there is no statistically significant difference among the two groups.
8. Crowded disc was totally seen in 6 patients including both unilateral and bilateral crowded disc.
9. Females had more crowded disc than the males in numbers but there is no statistically significant difference.
10. Among the watershed zones, type 2 constituted more in total and in males. In females it was both type 1 and type 2. This proved to be a statistically significant difference.
11. Delayed filling was seen in 2 patients which we have considered as

at risk patients for development of anterior ischemic optic neuropathy.

12. Hypoflourescent disc was seen in one patient and hyperflourescent disc was seen in one patient. Both may be at risk of developing anterior ischemic optic neuropathy.
13. At last in this study we come to a conclusion that more than half of the patients would need frequent , regular followups because we have considered those who have not taken regular treatment, patients having crowded disc, patients who had filling defects, patients who had type 2, 3, 4 watershed zones which involves the optic nerve head, patients who had hypo and hyperflourescent discs as AT RISK patients and so regular, frequent followup is needed than the rest , though others also need a regular followup but not as frequent as the previous group.

PART III

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PROFORMA:

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

ADDRESS: **PHONE NUMBER:**

CHIEF COMPLAINTS:

H/O PRESENTING ILLNESS:

PAST MEDICAL AND SURGICAL HISTORY:

DRUG ALLERGY:

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-

Examination of eyes :

UNCORRECTED VISUAL ACUITY BE -

VISUAL ACUITY WITH PINHOLE BE -

Tn BE

FIELDS

COLOUR Vn

OBLIQUE EXAMINATION:

OD		OS
	LIDS	
	CONJUNCTIVA	
	CORNEA	
	ANTERIOR CHAMBER	
	IRIS	
	PUPIL	
	LENS	

DILATED FUNDUS EXAMINATION(FIRST WITH DIRECT OPHTHALMOSCOPY AND THEN WITH SLITLAMP BIOMICROSCOPY WITH +90D LENS)

OD		OS
	MEDIA	
	DISC	
	C:D	
	VESSELS	
	A:V	
	MACULA	
	FR	

Fundus Flourescein Angiography :

DIAGNOSIS-

INVESTIGATIONS:

RBS

ESR

RENAL FUNCTION TESTS-

SERUM ELECTROLYTES-

BLOOD HEMOGLOBIN-

ELECTROCARDIOGRAM-

LFT

OTHER SPECIALITY OPINION AND FITNESS

GENERAL PHYSICIAN-

ANAESTHETIST-

MASTER CHART :

NAME	AGE	SEX	HYPERTENSION GRADING	DURATION OF HYPERTENSION	REGULARITY OF TREATMENT	BCVA- RE	BCVA - LE	CD ratio RE	CD ratio LE	WATERSHED Z	FILLING PATTE	HYPO/ NORMAL/HYPERFLO URESCENCE	NEED FOR FREQUENT FOLLOWUP
Jayalakshmi	63	F	I	11	R	6/60	6/36	0.3	0.3	Not seen	Normal	Normal	No
Ravichandran	53	M	II	15	IR	6/36	6/9	0.4	0.3	Type 2	Delayed	Normal	Yes
Bagyalakshmi	55	F	II	14	R	6/24	6/9	0.2	0.2	Type 3	Normal	Normal	Yes
Nirmala	56	F	III	10	R	6/60	6/60	0.3	0.3	Not seen	Normal	Normal	No
Baby	67	F	II	13	R	6/18	6/9	0.4	0.4	Not seen	Normal	Normal	No
Chellarani	56	F	I	12	R	6/9	6/36	0.2	0.2	Not seen	Normal	Hyperflourescent	Yes
Sembayi	57	F	II	15	IR	6/9	6/9	0.3	0.3	Type 2	Normal	Normal	Yes
Nilavathy	54	F	III	16	R	6/12	6/9	0.4	0.3	Not seen	Normal	Normal	No
Meena	58	F	I	11	IR	6/18	6/60	0.3	0.3	Type 2	Normal	Normal	Yes
Thangathaai	60	F	II	10	IR	6/60	6/9	0.2	0.3	Not seen	Normal	Normal	Yes
Periyakaruppan	51	M	II	18	IR	6/24	6/9	0.3	0.3	Type 2	Normal	Normal	No
Muthulakshmi	57	F	III	17	R	5/60	6/36	0.4	0.3	Not seen	Normal	Normal	No
Rajendran	52	M	II	15	IR	6/9	6/12	0.3	0.3	Type 3	Normal	Normal	Yes
Pandiyarajan	58	M	II	16	IR	6/18	6/12	0.3	0.3	Type 2	Normal	Normal	Yes
Chellamma	54	F	II	10	R	6/9	6/18	0.3	0.3	Type 1	Normal	Normal	No
Amudhan	66	M	II	11	R	6/24	6/9	0.2	0.2	Not seen	Normal	Normal	Yes
Lakshmi	69	F	I	12	R	6/12	6/60	0.3	0.3	Not seen	Normal	Normal	No
Shankarram	55	M	I	12	R	6/18	6/6	0.3	0.3	Not seen	Normal	Normal	No
Tamilarasan	59	M	II	14	IR	6/36	6/12	0.3	0.3	Type 2	Normal	Normal	Yes
Vishnu	53	M	III	10	R	6/36	6/9	0.3	0.3	Not seen	Normal	Normal	No
Senthilkumar	55	M	II	11	IR	6/60	6/12	0.3	0.3	Not seen	Normal	Normal	No
Badhusha	56	M	III	11	R	6/9	6/18	0.3	0.3	Type 5	Normal	Normal	No
Paulraj	67	M	II	16	IR	6/12	6/9	0.3	0.3	Not seen	Normal	Normal	No
Suruliyammal	57	F	I	18	IR	6/24	6/18	0.3	0.3	Type 2	Normal	Normal	Yes
Posiyammal	53	F	I	12	IR	6/36	6/36	0.2	0.3	Not seen	Normal	Normal	Yes
Pichaiyammal	54	F	I	16	IR	6/36	6/12	0.3	0.3	Type 2	Normal	Normal	Yes
Sugumari	59	F	II	13	R	6/9	6/9	0.3	0.3	Type 3	Normal	Normal	Yes
Latha	53	F	II	14	IR	6/12	6/60	0.3	0.3	Not seen	Normal	Normal	No
Pandiselvi	58	F	II	13	IR	6/24	6/12	0.3	0.3	Type 1	Normal	Normal	No
Revathy	51	F	III	11	IR	6/9	6/9	0.3	0.3	Not seen	Normal	Normal	No
Seenivasan	59	M	II	10	R	6/36	6/12	0.3	0.3	Type 2	Normal	Hypoflourescent	Yes
Sundarapandiyar	65	M	II	16	R	6/60	6/60	0.3	0.3	Type 3	Normal	Normal	Yes
Thaj	66	F	II	15	R	6/12	6/6	0.3	0.3	Type 4	Normal	Normal	Yes
Jaiganesh	71	M	I	12	IR	6/36	6/9	0.4	0.3	Not seen	Normal	Normal	No
Muthusamy	73	M	I	14	R	6/12	6/60	0.3	0.3	Type 2	Normal	Normal	Yes
Sowbar sultan	57	M	II	12	IR	6/24	6/9	0.3	0.3	Not seen	Normal	Normal	No
Palani	72	M	I	12	IR	6/18	6/12	0.3	0.3	Type 4	Normal	Normal	Yes
Varadharaj	59	M	II	16	IR	6/24	6/36	0.2	0.2	Type 2	Normal	Normal	Yes
Subbulakshmi	54	F	III	17	IR	6/9	6/9	0.3	0.3	Not seen	Normal	Normal	No
Setu	59	M	III	13	R	6/60	6/18	0.3	0.3	Type 1	Normal	Normal	No
Muthachi	58	F	III	12	R	6/36	6/9	0.3	0.3	Type 2	Normal	Normal	Yes
Veeranan	73	M	II	12	R	6/24	6/18	0.3	0.3	Type 2	Delayed	Normal	Yes
Muthukrishnan	64	M	II	11	IR	6/18	6/12	0.4	0.3	Type 2	Normal	Normal	Yes
Palanisamy	68	M	I	10	IR	6/18	6/6	0.3	0.3	Type 4	Normal	Normal	No
Karuppu	56	6/36	II	17	IR	6/24	6/18	0.3	0.3	Type 5	Normal	Normal	No
Kanchi	59	M	I	19	IR	6/36	6/9	0.3	0.3	Type 2	Normal	Normal	Yes
Kannan	56	M	III	12	R	6/24	6/12	0.3	0.3	Type 2	Normal	Normal	Yes
Gopal	52	M	I	10	R	6/6	6/24	0.4	0.3	Type 2	Normal	Normal	Yes
Seedhai	51	F	II	11	IR	6/36	6 18	0.4	0.3	Type 1	Normal	Normal	No
Thiruppathi	57	M	III	17	IR	6/60	6/12	0.3	0.3	Type 2	Normal	Normal	Yes

KEY TO MASTER CHART:

S.NO	ABBREVIATIONS	ABBREVIATIONS
1	F	female
2	M	Male
3	IR	irregular
4	R	regular
5	RE	right eye
6	LE	Left eye
7	BCVA	Best corrected visual acuity
8	CD ratio	cup to disc ratio

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.P.Jayadurga devi
Course	:	PG in MS., Ophthalmology
Course of Study	:	2017-2020
College	:	MADURAI MEDICAL COLLEGE
Research Topic	:	An observational study to study the pattern of optic nerve head filling in ***Fundus Flourecein Angiography*** in hypertensive patients with normal and crowded Optic Disc.
Ethical Committee as on	:	11.02.2019

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

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