Sudan University of Science and Technology

College of Graduate Studies

Study of Optic Nerve Diameter in Diabetic Patients Using Magnetic Resonance Imaging (MRI)

دراسة قطر العصب البصري لمرضي السكري باستخدام التصوير بالرنين المغنطيسي

A Thesis submitted in Fulfillment of the Requirement for Degree of Ph.D in Doctorate Philosophy Diagnostic Radiological Technology

By:

Sahar Abd Elwahed Osman Mustafa

Supervisor:

Prof. Caroline Edward Ayyad

Co – Supervisor:

Dr. Duha Abdu Mohammed Abdu

Associate professor

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الآية

بسم الله الرحمن الرحيم

قال تعالى :

"وَلِلَّهِ غَيْبُ السَّمَاوَاتِ وَالْأَرْضِ وَمَا أَمْرُ السَّاعَةِ إِلَّا كَلَمْحِ الْبَصَرِ أَوْ هُوَ أَقْرَبُ إِنَّ اللَّهَ عَلَى كُلِّ شَيْءٍ قَدِيرٌ . وَاللَّهُ أَخْرَجَكُمْ مِنْ بُطُونِ أُمَّهَاتِكُمْ لَا تَعْلَمُونَ شَيْئًا وَجَعَلَ لَكُمُ السَّمْعَ وَالْأَبْصَارَ وَالْأَفْئِدَةَ لَعَلَّكُمْ تَشْكُرُونَ "

سورة النحل

الأيات (77 ، 78)

Dedication

To my family

Acknowledgement

Great thanks to Allah to let me reaching this place.

I would like to thank very much supervisor ***Prof. Caroline Edward****; the supervisor of my thesis for her continues help, supervision and guidance .*

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Thank are also extended to everyone who helped me in different way to make this work is possible.

I would thank my family Father, Mother, Husband, Daughters, Brothers, and my Sisters for their continuous mental supported.

Finally, I'm sincerely grateful to all my patients for their co-operation and giving informed consent to participate in this study.

List Abbreviations

CNS	Central Nervous System
CSF	Cerebro Spinal Fluid
CT	Computed Tomography
CVD	Cardio Vascular Diseases
DKA	Diabetic ketoacidosis
DM	Diabetes mellitus
DR	Diabetic Retinopathy
HNS	Hypero smolar Nonketotic State
ICA-ab	Islet Cell Antibody
ICP	Intracranial Hypertension
IDDM	Insulin-Dependent Diabetes Mellitus
IIH	Idiopathic Intracranial Hypertension
GAD65Ab	Glutamic acid decarboxylase-65 antibody
Max	Maximum
Min	Minimum
MRI	Magnetic Resonance Imaging
NIDDM	Non Insulin-Dependent Diabetes Mellitus
OA	Ophthalmic Artery
ON	Optic Nerve
OND	Optic Nerve Diameter
ONL	Optic Nerve Length
ONS	Optic Nerve Sheath
ONSD	Optic Nerve Sheath Diameter
RF	Radio Frequency
SAS	SubArachnoid Space
StD	Stander Deviation
TED	Thyroid eye disease

Abstract

The type of study aims to evaluate the impact of diabetic in optic nerve measurement using magnetic resonance imaging (MRI). And to establish the standard value of the optic nerve measurement for Sudanese healthy and compare the normal measurements with patients mentioned diabetic disease.
The study was carried out during the period from January 2015 to January 2018 at Antalya Medical Center hospital and Royal Care International Hospital-Khartoum, Sudan.

MRI images examination for both eyes were obtained, with magnetic field strength1.5T, the axial T2-weighted turbo spin-echo fat-suppressed sequence was used to measure optic nerve sheath diameter (ONSD), optic nerve diameter (OND) and optic nerve length (ONL).

The sample was divided into two groups: Group: 1 including one hundred was considered as control, males were 45% and females were 55%. Their ages were between (18-80) years old with mean 39.46 years±15.81.Group: 2 including fifty diabetic patients. MRI exams were done for right and left optic nerves and optic sheath. Males were 52% and female were 48%. Their age ranged from 23-84 years old with mean age of 59.4 years ± 13.7.

The overall mean length of the right and left optic nerve for all the patients studied was 46.82 ± 1.46. From the minimum was 43.40 and maximum was 50.09 in the right side and from 43.39 to 50 in maximum.

The study revealed a reference values measured in axial MRI for OND was 3.05±0.23 for the right side and 3.05 ±0.22 for the left side , The mean ONSD in the diabetic group was 5.03 ± 0.53mm for the right, and 5.08±0.48 for the left ,and showed no difference from that in control group p = 0.795 and 0.742 respectively.

The study indicated that MR OND measurements in diabetic patients differ from the reference values that have been read from normal in the control group .There is significant deference between measurement done for the optic nerves diameters between diabetic and control group. p=0.000.linear relationship between the duration of diabetic with right and left optic nerve diameter measurements was found.

The study concluded that diabetes affected the OND and it was significantly decreased than that in healthy controls.

New equations were established for the prediction of the OND changes in patients with known duration of diabetics for both right and left optic nerves.

According to the study, the OND is significantly decreasing than that in healthy controls.

The study concluded that MRI has great value in measurement of the optic nerve diameter in diabetic patients.

The study suggested some recommendations and future studies which could be useful in this domain.

المستخلص

يهدف نوع الدراسة الي تقييم تأثير السكري في قياس العصب البصري باستخدام التصوير بالرنين المغناطيسي وذلك لتحديد القيمة القياسية لقياس العصب البصري للسودانيين الأصحاء ومقارنة القياسات الطبيعية مع تلك الخاصة بمرضى السكري.

أجريت الدراسة خلال الفترة من يناير 2015 إلى ديسمبر 2018 في مستشفى مركز أنطاليا الطبي ومستشفى الرويال كير – الخرطوم ، السودان.

تم فحص وتقويم كلتا العينين اليمني واليسرى بواسطة برتوكول العين لجهاز الرنين. كان تجميع العينات بواسطة نموذج البيانات وحللت بواسطة برنامج التحليل الاحصائي (SPSS) . تم استبعاد المرضي المصابين بإمراض العيون وارتفاع ضغط الراس المعروف في المجموعة الضابطة.

تم تقسيم الدراسة الي مجموعتين المجموعة الاولي كانت معايير الادراج 50 مريض مصاب بالسكري تتراوح اعمارهم من (23 – 84) ويمثل عدد 52% رجال وعدد 48% من النساء. اما المجموعة الثانية كانت عبارة عن المجموعة الضابطة كانت معايير الادراج 100 شخص تتراوح اعمارهم من (18 – 80) ويمثل عدد 48% من الرجال وعدد 55% من النساء.

اخذت قياسات عرضية وقياسات طولية للعصب البصري وكان متوسط الطول للعصب البصري في الطبيعي 46.82 ± 1.41 وكان اقل قياس هو 43.40 واعلي قياس هو 50.09

وكشفت الدراسة عن قيم مرجعية تم قياسها في التصوير بالرنين المغناطيسي المحوري للعصب البصري كانت 3.05 ± 0.23 للجانب الأيمن و 3.05 ± 0.22 للجانب الأيسر

،

وكان متوسط قياس القشرة الخارجية للعصب البصري في المجموعة المصابة بالسكري 5.03 ± 0.53 ملم جهة اليمين ، و 5.08 ± 0.48 لـ اليسار ، وأظهرت الدراسة لا فرق من ذلك في مجموعة التحكم لليمين0.795 = p وللليسار 0.742 =pعلى التوالي.

أشارت الدراسة إلى أن قياسات العصب البصري في مرضى السكري تختلف عن القيم المرجعية التي تمت قراءتها من الطبيعي في المجموعة الضابطة هناك اختلاف كبير بين قياس قطر العصب البصري بين مرضى السكري ومجموعة السيطرة. (P = 0.000)وتم العثور على علاقة خطية بين مدة مرض السكري مع القياسات اليمنى واليسرى لقطر العصب البصري.

وخلصت الدراسة إلى أن مرض السكري يؤثر على قطر العصب البصري وانخفض بشكل كبير من ذلك في الضوابط الصحية.

تم إنشاء معادلات جديدة للتنبؤ بالتغيرات في المرضى الذين يعانون من مرضى الفترة الزمنية المعروفة لمرضى السكر لكل من الأعصاب البصرية اليمني واليسرى.

ووفقًا للدراسة ، يتناقص قطر العصب البصري بشكل كبير عن تلك الموجودة في أدوات التحكم الصحية.

خلصت الدراسة إلى أن التصوير بالرنين المغناطيسي له قيمة كبيرة في قياس قطر العصب البصري لمرضي السكري.

اقترحت الدراسة بعض التوصيات والدراسات المستقبلية التي يمكن أن تكون مفيدة في هذا المجال.

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Chapter One

Introduction

1.1 Introduction:

The optic nerve is the nerve that connects and transmits information between the eye and the brain.

The optic nerve is the located in the back of the eye. It is also called the second cranial nerve or cranial nerve II. It is the second of the several pairs of cranial nerves. Although the optic nerve is part of the eye, it is considered to be in the central nervous system.(Kelly, et al 2007).

The optic nerve is composed of retinal ganglion cell axons and support cells. It nerve begins at the optic disk, a structure that is 1.5mm (0.06 inch) in diameter. The optic disk forms from the convergence ganglion cell out fibers (called axons) as they pass out of the eye. When the nerve emerges from the back of the eye, it passes through the remainder of the posterior orbit (eye socket) and through the bony optic canal to emerge intracranially on the underside of the front of the brain. At this point the optic nerve from each eye comes together and forms an X- shaped structure called the optic chiasm. (Khurana, 2006).

The function of the optic nerve is to transfer visual information from the retina to the vision centers of the brain via electrical impulses. The optic nerve is made of ganglionic cells or nerve cells. It consists of over one million nerve fibers. When examining the back of eye, a portion of the optic nerve called the optic disc can be seen.

Diabetes is not a single disease but the pathological and metabolic state caused by inadequate insulin action a feature common to all types is glucose intolerance. (Roderick, et al 2001).

Hyperglycemia refers to abnormally high blood sugar levels and this occurs when there is not enough insulin in the body.

The diabetes is a risk factor for glaucomatous optic neropathy. Diabetes is also among the risk factors for optic disc hemorrhages in glaucoma. Elevated blood glucose levels cause an elevated retinal glucose level, resulting in a hypoxic – like redox imbalance that may contribute to the ischemia those preceders the development of diabetic retinopathy. (Yanoff, 2009)

Of the many imaging techniques, MR imaging has been of particular interest because of its ability to provide gross visualization of the optic globe, ON, orbits, and optic tract. (Passi, et al 2012).Additionally, MRI allows excellent depiction of the intricate anatomy of optic nerves due to its excellent soft tissue contrast without exposure to ionizing radiation, better delineation of the entire visual pathway;

(Gala, 2015) provides higher soft-tissue contrast and free section orientation capabilities compared with CT and appear to be more accurate in assessing the ON than sonography. (Passi, et al 2012).

1.2 Study problem:

Over time, the high sugar levels in the blood may damage the nerves and small blood vessels of the eyes and optic nerves. The importance of research gives the measurement of optic nerve and detects the impact of diabetic in the optic nerve. A clear understanding of MR imaging protocols, key anatomical structures, is to detect the decreasing in optic nerve measurement occurred due to the diabetes mellitus changes in the optic nerve nature.

1.3 Objective:

1.3.1 General objective:

To characterize the optic nerve in diabetic patient by using MRI.

1.3.2 Specific objective:

To measure the diameter and length of optic nerve.
To compare the findings with control group.
To compare the right and left optic nerve.
To correlate the finding of optic nerve measurement with age, gender, and duration of diabetic.
To evaluated the indices of the optic nerve measurement in axial fatsat MRI cuts.

1.4 Study layout:

This study contains five chapters:
Chapter one: deals with introduction.
Chapter two: Theoretical back ground & previous literature review.
Chapter three: Materials & Method.
Chapter four: Data analysis &Results.
Chapter five: Discussion, Conclusion, and Recommendation.

Chapter Two
Literature Review

Chapter Two

Theoretical Background

2.1 The Anatomy:

2.1.1 The Orbit:

The orbit is pyramidal cavity with its base anterior and apex posterior. The orbital margin is formed above by the frontal bone, and lateral margin is formed by the processes of the frontal and zygomatic bones, the inferior margin is formed by the zygomatic bone and the maxilla, and the medial margin is formed by the processes of the maxilla and the frontal bone. (Snell, 2012).

2.1.2 The Eye Ball:

The eye ball is embedded in orbital fat but is separated from it by fascial sheath of eyeball. The eyeball consists of three coats, which, from without inward, are the fibrous coat, the vascular pigmented coat, and the nervous coat.

The fibrous coat; is made up of a posterior opaque part, the sclera, and an anterior transparent part, the cornea. (Snell, 2012).

The opaque sclera is composed of dense fibrous tissue and is white. Posteriorly it is pierced by the optic nerve and is fused with the dural sheath of that nerve. The sclera is directly continuous in front with the cornea at the corneoscleral junction, or limbus. (Snell, 2012).

Vascular pigmented coat; consist from behind forward, of the choroid, the ciliary body, and the iris.

Nervous coat (retina); It is concerned with visual functions. (Snell, 2012).

The eyeball can be divided into segments, anterior and posterior; the anterior segment includes crystalline lens (which is suspended from the ciliary body by zonules), and structures anterior to it, viz, iris, cornea and two aqueous humour-filled spaces, anterior and posterior chambers. (Khurana et al, 2006)

The anterior chamber; it is bounded anterioly by back of cornea, and posterioly by the iris and part of ciliry body. The anterior chamber is about 3.0 mm deep (range 2.5 – 4.4 mm) in the centre in normal adults. It contains about 0.25 ml of the aqueous humour.

The posterior chamber; it is a tringular space containing 0.06 ml of aqueos humour. It is bounded by the anteriorly by the posterior surface of the iris and part of ciliary body, posteriorly by crystalline lens and its zonules, and laterally by the ciliary body. (Khurana et al, 2006)

The posterior segment. It includes the structures posterior to lens, viz, vitreous humour, and retina, choroid and optic disc. (Khurana et al, 2006)

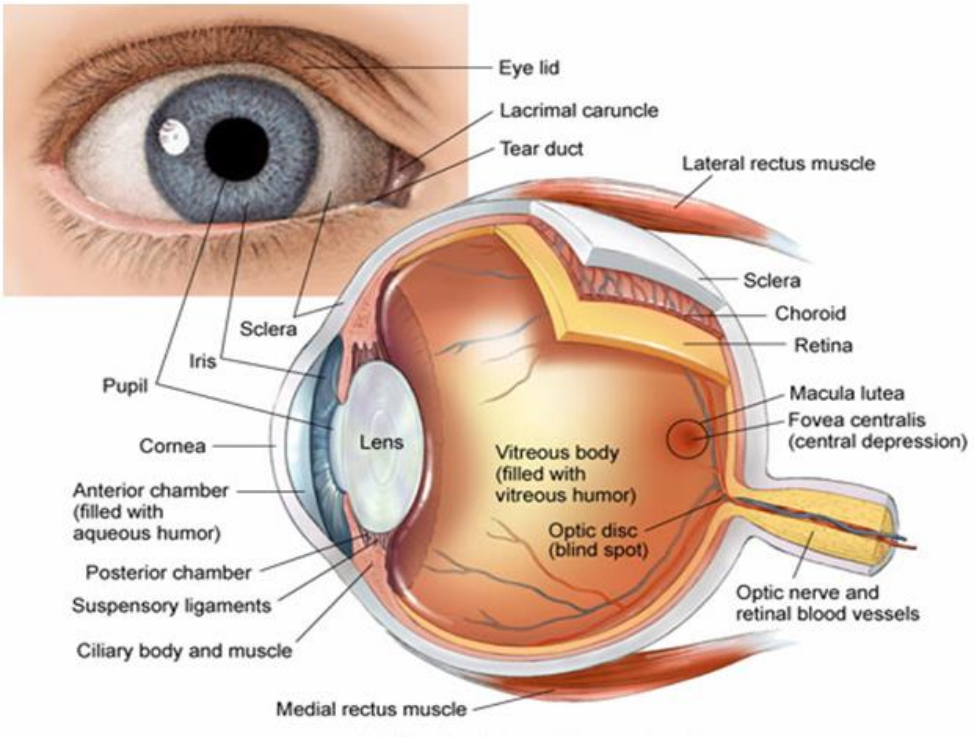


Figure 2.1 shows the anatomy of the right eye
https://owlcation.com

2.1.3 The Retina:

Retina, the innermost tunic of the eyeball, is a thin, delicate and transparent membrane. It is the most highly developed tissue of the eye. It appears purplish – red due to visual purple of the rods. After death of a person, the retina appears white opaque. On the ophthalmoscopic examination it can be divided into three distinct regions: optic disc, macula lutea and rest of the peripheral retina (general fundus) (Khurana et al, 2006).

The retina has 10 layers, the arrangement of these layers can appreciated when it is realized that the light receptors. (Sukker, 2000) consists of an outer pigmented layer and an inner nervous layer. Its outer surface is in contact with the choroid, and its inner surface is in contact with the vitreous body. The posterior three fourths of the retina is the receptor organ. Its anterior edge forms a wavy ring, the ora serrata, and the nerves tissiue end here. Anterior part of the retina is non receptive and consists merely of pigment cells, with a deeper layer of columnar epithelium. This anterior part of the retina covers the ciliary processes and the back of the iris. (Snell, 2012).

At the center of the posterior part of the retina is an ovel, yellowish area, the macula lutea, which is the area of the retina for the most distinct vision. It has a central depression, the fovea centralis. (Snell, 2012).

The optic nerve leaves the retina about 3mm to the medial side of macula lutea, by the optic disc. The rods and cones face the pigment layer towards the outer side of the eyeball, and that the rods and synapse with bipolar neurons, which synapse in turn with ganglion cells, the axons of which constitute the optic nerve fibres. The 10^{th} layer is an internal limiting membrane. Horizontal cells make synaptic connections with and between receptors, while amacrine cells, having no axons but numerous processes, make horizontal connections between ganglion cells. There are no rods or cones on the optic disc, which is consequently, blind (the blind spot). The fovea centralis contains only cones. At the fovea, the blood – vessels and retinal neurons are displaced to the sides, so that rays pass directly to the cones. The density of cones falls sharply in the periphery of the retina. (Sukker, 2000)

The reason we normally do not notice our blind spots is because, when both eyes are open, the blind spot of one eye corresponds to retina that is seeing properly in the other eye. (Montgomery, 2011).

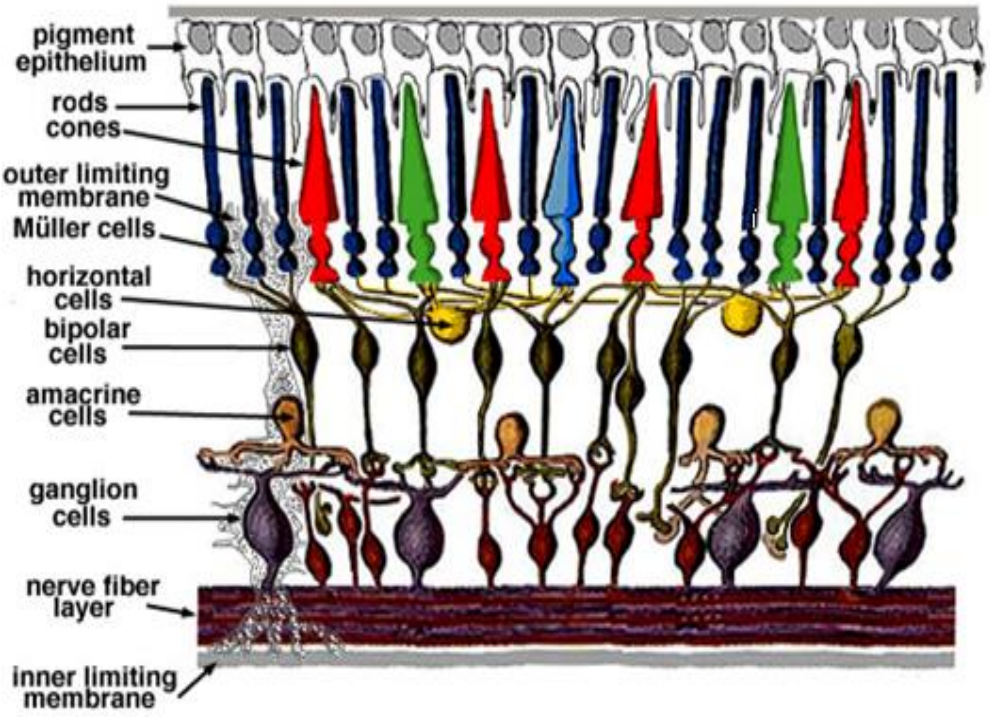


Figure 2.2 shows the simple diagram of the organization of retina
http://madeinkibera.com

2.1.4 Visual pathway; Optic nerve:

The optic nerve (second cranial nerve) is composed of the axons of the cell of the ganglionic layer of the retina. Starts from the back of eyeball and leaves the orbital cavity through the optic canal to enter the cranial cavity. The optic nerve then unites with the optic nerve of the opposite side to form the optic chiasma. It is the

backward continuation of the nerve fibre layer of the retina which consists of axons originating from the ganglion cells. It also contains the afferent fibres of light reflex and some certrifugal fibres. (Snell, 2012).

Morphologically and embryologically, the optic nerve is comparable to a sensory tract (white matter) of the brain, because of the optic nerve is an outgrowth of the brain, unlike peripheral nerve; it is not covered by neurilemma (so it not regenerate when cut), the fibres of optic nerve numbering about a million are very fine, 2 – 10µm in diameter as compared to 20µm in sensory nerves, the optic nerve surrounded by meninges and both the primary and secondary neurons are in the retina. (Khurana et al, 2006)

The optic nerve is about 47 – 50mm in length and can be divided into four parts; intraocular, intraorbital, intracanalicular and intracranial.

Intraocular; this part passes through the sclera, choroid and finally appears in eye as optic disc. It has average diameter of 1.5mm, which expands to approximately 3mm just behind the sclera. The optic nerve head divided into four portions from anterior to posterior; surface nerve fibre layer, prelaminar region, lamina cribrosa and retrolaminar region. (Khurana et al, 2006)

Intraorbital part of the optic nerve extends from back of the eyeball to the optic foramina. This part is slightly sinuous to give play for the eye movement.

The optic nerve in this region is cover by dura,arachnoid, and pia. The pial sheath contains capillaries and sends septa to divide the nerve into fascicule. The subarachnoid space containing cerebrospinal fluid ends blindly at the sclera but continues intracranially. (Khurana et al, 2006)

The central retinal artery along with the accompanying vein crosses the subarachnoid space to enter the nerve on its inferomedial aspect about 10mm from the eyeball. Posteriorly, near the optic foramina, the optic nerve is closely surrounded by the annulus of zinn and the origin of the rectus muscles. Some fibres of the superior rectus muscle and medial rectus muscle are adherent to its sheath here and account for the painful ocular movements seen in retrobulber neuritis. Anteriorly, the nerve is separated from the extraocular muscles by orbital fat.

The long and short ciliary nerves and arteries surround the optic nerve before these enter the eyeball. Between the optic nerve and lateral rectus muscle are situated the ciliary ganglion, divisions the oculomotor nerve, the nasociliary nerve, the sympathetic and the abducent nerve. (Khurana et al, 2006)

The ophthalmic artery, superior ophthalmic vein and the nasociliary nerve cross the optic nerve superiorly from the lateral to medial side.

Intracanalicular part is closely related to the ophthalmic artery which crosses the nerve inferiorly from medial to lateral side in the dural sheath and then leaves the sheath at the orbital end of the canal.

The sphenoid and posterior ethmoidal sinuses lie medial to it and are separated by a thin bony lamina. This relation account for retrobulber neuritis following infection of the sinuses.
Intracranial part of optic nerve, about 1cm in length, lies above the cavernous sinus and converges with its fellow (over the diaphragm sellae) to form the chiasma. It is ensheathed in pia mater only. (Khurana et al, 2006)
The internal carotid artery runs, at first below and then lateral to it. The ophthalmic artery arises from the internal carotid artery below the optic nerve at about its middle. The anterior perforated substance, the medial root of the olfactory tract and the anterior cerebral artery lie above this part of the optic nerve.
Meningeal sheaths of optic nerve; the intracranial part of optic nerve is covered by pia only, while the intracanalicular and intraorbital parts of the nerve three coverings; pia, aracnhniod, and dura. All the meningeal sheaths and the subarachnoid and the subdural space around the optic nerve are continuous with those of the brain. Anteriorly, all the three meningeal sheaths terminate by becoming continuous with the sclera. At the apex of the orbit, the dura splits into layers, the outer is continuous with the periosteum of the orbit while the inner forms the dural sheath of the optic nerve. Archniod layer is connected to pia with numerous trabeculae. These connections have led to the concept of a compound pia – arachnoid meninx, containing cerebrospinal fluid (CSF). Pia meter sends numerous septa into the optic nerve, dividing its fibres into fascicles. In fact, these septa are admixture of pia and glial tissue, leading to the term "pia – glia".
The optic chiasma is a flattened structure measuring about 12mm horizontally and 8mm anteroposteriorly. It is ensheathed by the pia and surrounded by cerebrospinal fliud. It lies over the diaphragm sella and therefore presence of a visual field defect in a patient with a pituitary tumour indicates suprasellar extension. Posteriorly, the chiasma is continuous with the optic tracts and forms the anterior wall of the third ventricle. (Khurana et al, 2006)
Variations in the location of the chisma may have important clinical significance as follows;
Central chiasma is present in about 80% of the normal cases. It lies directly above the sella.
Prefixed chiasma is present in about 10% of normal cases. It is located more anteriorly over the tuberculum sellae.
Postfixed chiasma is present in the remaining 10% of normal cases. It is located more posteriorly over the dorsum sellae.
The optic tracts are cylindrical bundles of nerve fibres running outwards and backwards from the posterolateral aspect of the optic chiasma. It is carry fibres from the retinal and macular halves of the same side, i.e. the right optic tract carries fibres from the right halves of both retinae and maculate, and fibres from

the left halves of the retinae and maculae are carried in the left optic tract, for the field of vision, the directions are reversed, e.g. the left optic tract carries impulses coming from the right half of each field of vision. Optic tract fibres synapse in the lateral geniculate body of the thalamus. Each geniculate body consists of six layers of neurons (grey matter) alternating with white matter (formed by optic fibres). The optic radiation or geniculocalcarine pathway extends from the lateral geniculate body to the visual cortex. The fibre of optic radiations then spread out fanwise to form a medullary optic lamina. This is at first vertical but becomes horizontal near the visual cortex. The visual cortex is located on the medial aspect of the occipital lobe in and near the calcarine fissure. It may be extend on to lateral aspect of the occipital lobe, but limited by a semilunar sulcus, the sulcus lumates. (Khurana et al, 2006)

Arrangement of nerve fibres in visual pathway according to area of optic nerve; in the optic nerve head arrangement of nerve fibres is exactly same in the retina. And in the distal region of optic nerve, the nerve fibres are distributed exactly as in the retina, i.e the upper temporal and lower temporal fibres are situated on the temporal half of the optic nerve and are separated from each other by a wedge shaped area occupied by the papillomacular bundle. The upper nasal and lower nasal fibres are situated on the nasal side.

But in the proximal region of optic nerve near the chisma the macular fibres are centrally placed. (Khurana, 2006).

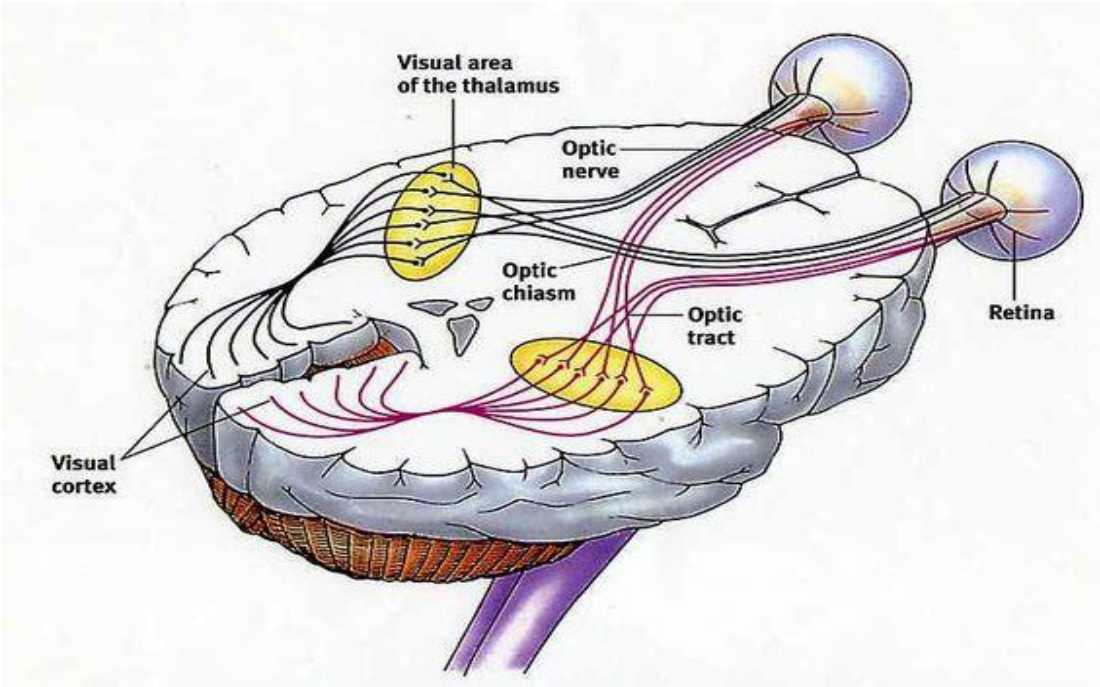


Figure 2.3 shows the visual pathway; optic nerve
http://www.edoctoronline.com

2.1.5 Blood vessels &lymph vessels of the orbit:

The ophthalmic artery is a branch of the internal carotied artery after that vessel emerges from the cavernous sinus. It enters the orbit through the optic canal with optic nerve. It runs forward and crosses the optic nerve to reach the medial wall of the orbit. It gives off numerous branches, which accompany the nerves in the orbital cavity. (Khurana et al, 2006)

The central artery of the retina is a small branch that pierces the meningeal sheaths of optic nerve to gain entrance to nerve. It runs in substance of the optic nerve and enters the eyeball at the center of the optic disc. Here, it divides into branches, which may be studied in the patient through an ophthalmoscope. The branches are end arteries. And the muscular branche. The ciliary arteries can be divided into anterior and posterior groups. The former group enters the eyeball near the corneoscleral junction; the latter group enters near the optic nerve. And the lacrimal artery supplies the lacrimal gland. The supratrochlear and supraorbital arteries are distributed to the skin of the forehead. And there are no lymph vessels or nodes present in the orbital cavity. (Khurana et al, 2006)

Ophthalmic veins; the superior ophthalmic vein communicates in front with the facial vein. The inferior ophthalmic vein communicates through the inferior orbital fissure with the pterygoid venous plexus. Both veins pass backward through the superior orbital fissure and drain into the cavernous sinus. (Khurana et al, 2006).

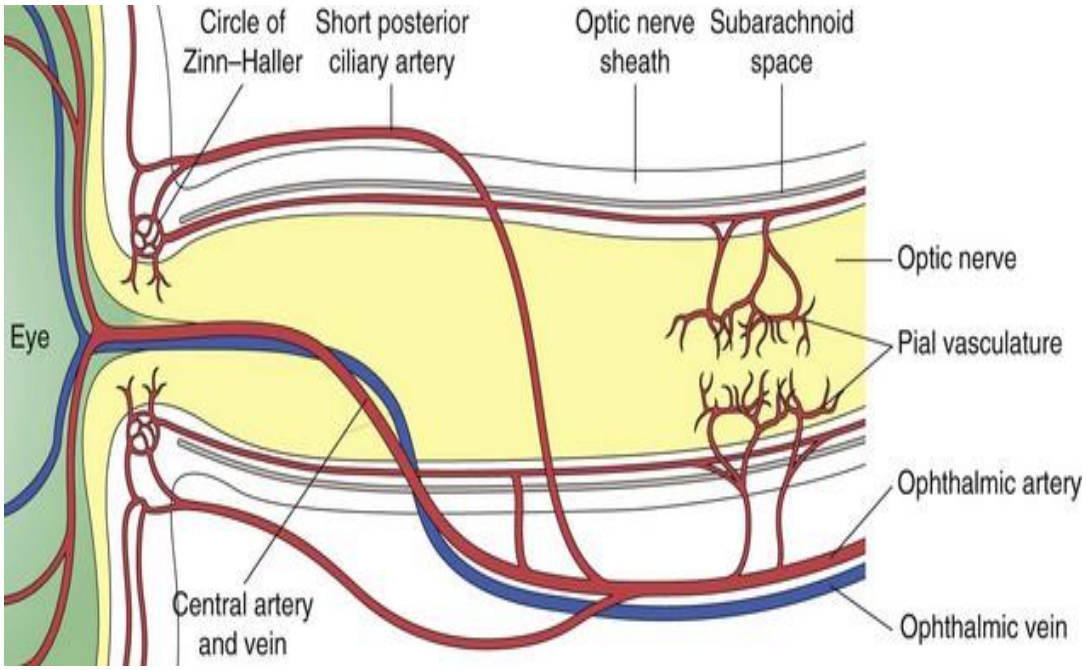


Figure 2.4 shown the sheath and the vascular supply to the intraocular and intraorbital portions optic nerve
https://clinicalgate.com

2.2 Physiology of the eye:

Light passes through most of the retinal layers before reaching and stimulating the photoreceptor outer segment discs. The neural flow then proceeds back through the retinal elements in the opposite direction of the incident light. The efficient and accurate performance of the retina is not hampered by this seemingly reversed situation. (Remington, 2012)

The process, by which a photon of light is changed to an electrical signal, occurs in the photoreceptors. Visual pigments in the photoreceptor outer segment absorb light, initiating the process of vision. (Remington, 2012)

Since light travels in straight lines, the right half of the retina views the half of the field of vision and the upper half of the retina looks at the lower half of the visual field, and vice versa. In the study of vision, the terms temporal and nasal are preferred to lateral and medial. Fibres from the temporal half of the retina on each side proceed on same side, while fibers from each of the nasal halves of the retina cross to the opposite side. fibres from macula on each side behave in exactly the same way. (Sukker, 2000)

The optic tracts carry fibres from the retinal and macular halves of the same side.

For field of vision, the directions are reversed i.e the left optic tract carries impulses coming from the right half of each field of vision. (Sukker, 2000)

The visual perceptions are the functional elements of the vision – the sensations which result from stimulation of retina with light. These are of four kinds, namely: the light sense, the form sense, the contrast sense and the colour sense. (Khurana et al, 2006)

The visual system is highly specialized for the detection and analysis of patterns of light; by visual adaptation, it can modify its capacity to respond at extremely high and low levels of illumination. The level of background illumination can affect the both the ease and the speed with which a photoreceptor responds. When a significant change in light level occurs, adaptation can be prolonged; it can take 30 minutes for the retina to adapt fully when going from bright sunlight to complete dark (dark adaptation). (Remington, 2012)

At first only cones are functioning, but since they are now in the dark they are not stimulated and the rods take some time to reach maximum function.

Light adaptation, going from complete dark to bright light, takes approximately 5 to 10 minutes; the cones reach their functional mode much more quickly than do rods. (Remington, 2012)

The extensive network of continual intracellular communication requires extensive energy utilization by retinal tissue. The primary source of energy is provided by glucose metabolism. Glucose moves out of the blood and into retinal tissue via facilitated diffusion; glucose transporters are located on both the apical and basal

membranes of the retinal pigmented epithelial cell and on the endothelium of retinal capillaries. The retina can switch from glycolysis to oxidative metabolism depending on need, but even under normal physiologic conditions the retina has a high rate of anaerobic glycolysis. Müller cells store glycogen, providing a ready source for glucose. Because energy requirements are high, oxygen consumption is high. In dark, the photoreceptors consume so much oxygen that the oxygen tension in the tissue is near zero and the photoreceptors are operating under near ischemic conditions. (Remington, 2012)

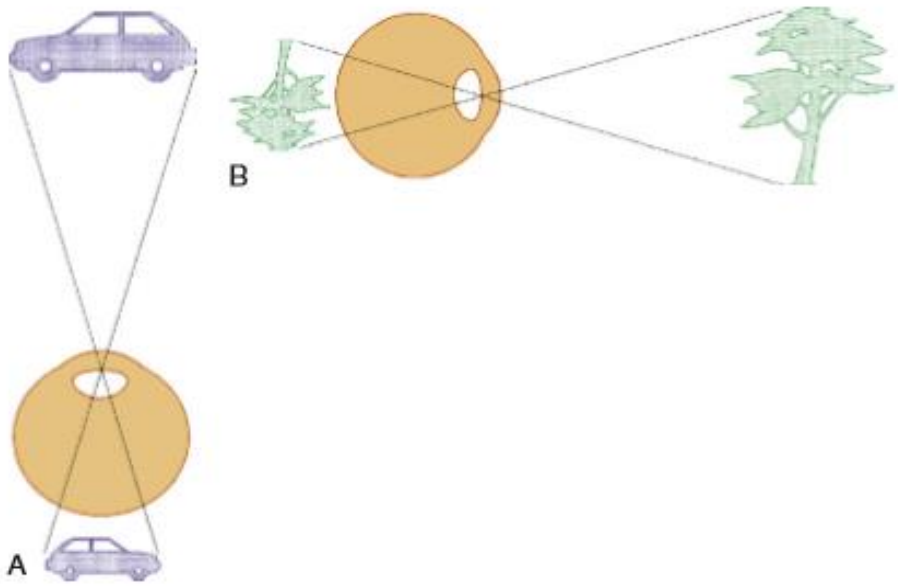


Figure: 2.5 Orientation of an image on the retina. A, Nasal field is imaged on temporal retina. B, Superior field is imaged on inferior retina.

2.3 Pathology of the eye:

2.3.1 Retinal detachment:

In myopia and in the ageing eye, there are areas of retinal thinning at the equator. Vitreous traction causes tears in the atrophic retina and fluid from the vitreous separates the photoreceptors from the pigment epithelium. This separation deprives the photoreceptors of their metabolic support and there is loss of visual field corresponding to the region of the detachment. (MacSween, 2001)

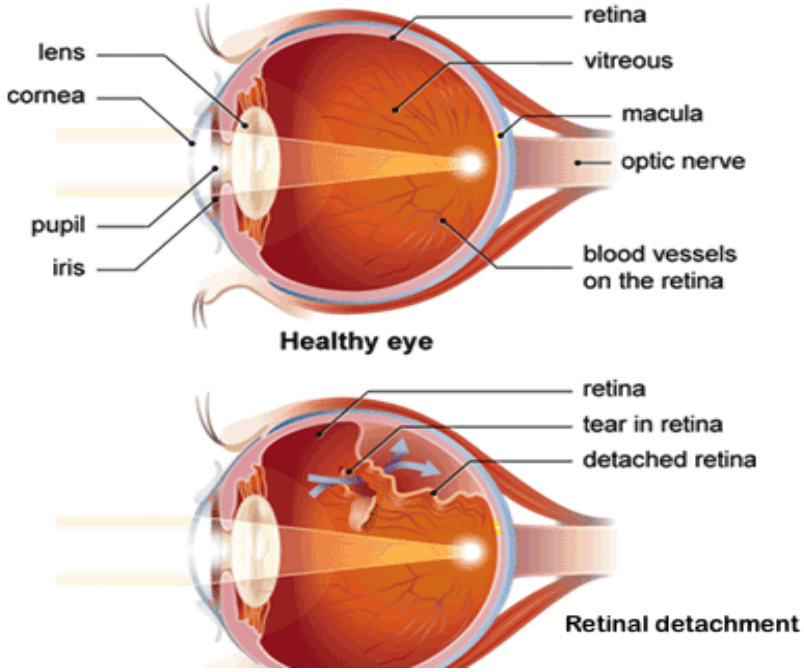


Figure 2.6: shows eye with retinal detachment
www.visionandsurgery.com

2.3.2 Cataract:

The biconvex lens substance is formed by cells which contain crystalline lens proteins. The cells are enclosed in an elastic membrane, the lens capsule. The malleability of the lens permits rapid fine focusing by tension exerted on the lens equator by ciliary muscle via the zonular fibres. Any change in the biochemical composition of the aqueous fluid may result in formation of abnormal (opaque) proteins in the damaged lens cells. Thus, opacities may occur after trauma, in uveitis and in metabolic diseases, e.g. diabetes mellitus and hypocalcaemia. The most common form of cataract, however, is senile cataract which is due to degradation of lens proteins in the oldest central part of the lens: yellow and eventually dark brown proteins are formed. Most cases of cataract are treated successfully by removal of the opaque lens implant into the residue of the lens capsule. (MacSween, 2001)

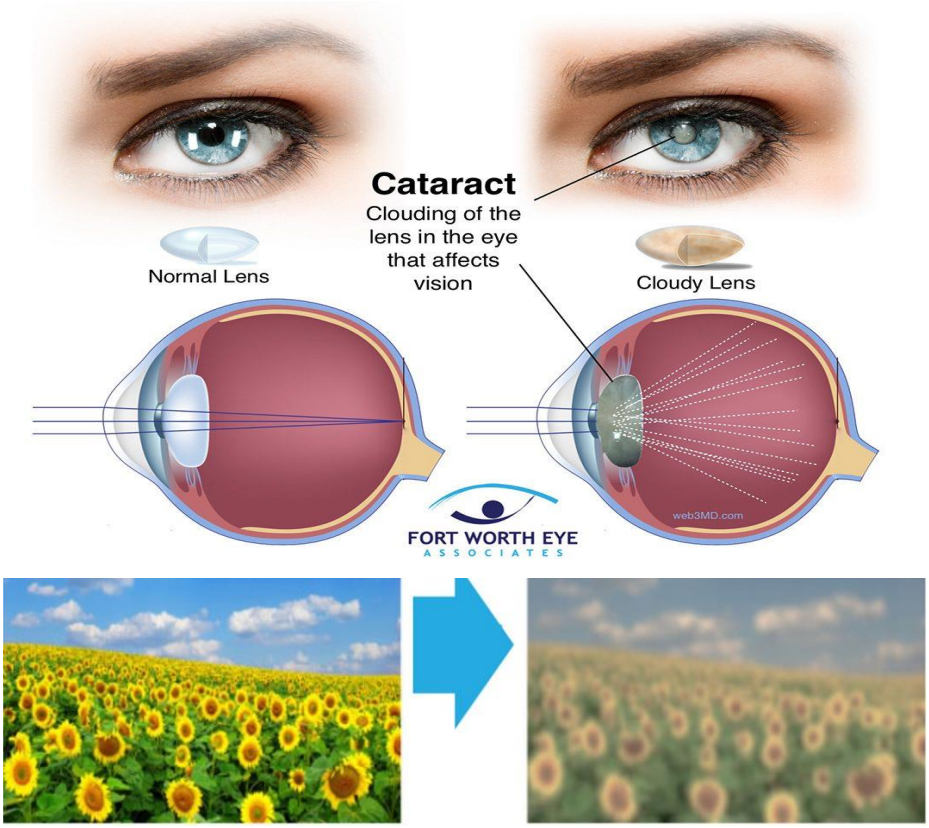


Figure 2.7: Shows vision through a Cataract.
http://www.ranelle.com

2.3.3 Glaucoma:

Glaucoma is generic name for a group of diseases in which, for a variety of reasons, the intraocular pressure increase to a level which impairs the vascular perfusion of the neural tissue and causes blindness. The rise in pressure is due to obstruction to the outflow of aqueous, which occurs either as result of closure of the chamber angle (iridtrabecular contact) or as the result of an abnormality within the outflow system.

2.3.3.1Closed – angle glaucoma:

In the primary form the iridocoronal angle is narrow and the anterior chamber is shallow. In such individuals the iris and lens may come into contact when the iris is in mid – dilatation: this prevents the flow of aqueous through the pupil and pressure builds up behind the iris. Untreated, there is blindness due to ischaemic atrophy of the optic disc.

Secondary closed – angle glaucoma has many causes, but the most common is due to fibrovascular adhesion between iris and cornea following ischaemic retinal disease and uneitis. (MacSween, 2001)

2.3.3.2Open – angle glaucoma:

The primary type is an insidious disease of the elderly in which a slowly progressive increase in intraocular pressure leads to an interruption of axoplasmic flow in the nerve fibres in sectors of the optic disc. (MacSween, 2001)

In secondary open – angle glaucoma the outflow system is obstructed mechanically by cells or particulate matter. In acute or chronic inflammatory disease. The outflow system can be obstructed by tumour cell infiltration, e.g by a malignant melanoma of the iris or ciliary body. (MacSween, 2001)

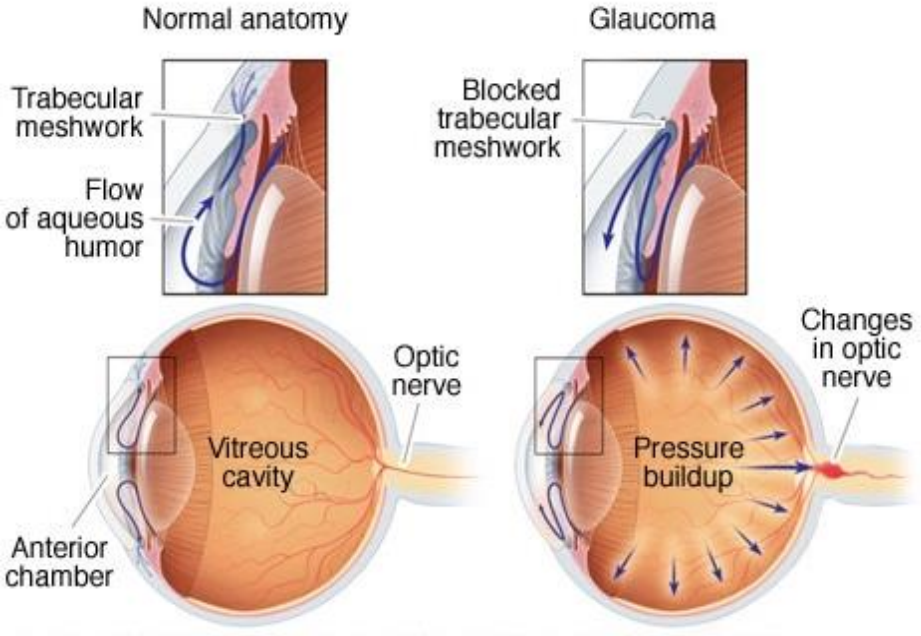


Figure 2.8 shows Open – angle Glaucoma
www.mayoclinic.org

2.3.4 The effects of increased intraocular pressure:

The most serious effects on the visual functions are due to ischeamic atrophy of the axons in the nerve fibres of the disc, and secondary atrophy in the nerve layer of the retina. Excavation or cupping of the disc may become so advanced that it extended into the optic nerve. (MacSween, 2001)

In infants and children, glaucoma can result from developmental abnormalities in which there is a failure in modelling of the embryonic tissues which are found in the chamber angle in the early stages of intrauterine life. Increasing intraocular pressure causes the malleable infantile eye to expand uniformly and it may become so large that it resembles an ox – eye (‘buphthalomos’). (MacSween, 2001)

2.3.5 Papilledema:

Any condition in which the intracranial pressure is raised can cause p apilloedema. The prelaminar part of the optic disc is swollen and the peripapillary photoreceptors are placed laterally. If the reason for the papilloedema is not

identified, the oedema can present as a tumour. This so-called pseudotumour cerebri is treated by optic nerve fenestration to relieve the pressure in the subarachnoid space. The pathologist will receive the meninges surrounding the optic nerve, which are histologically completely normal. (Cardesa, et al 2006)

2.3.6 Ischemic optic neuropathy:

"Ischemic optic neuropathy" is a severely blinding disease resulting from loss of the arterial blood supply to the optic nerve (usually in one eye), as a result of occlusive disorders of the nutrient arteries. Optic neuropathy is divided into anterior, which causes a pale edema of the optic disc, and posterior, in which the optic disc is not swollen and the abnormality occurs between the eyeball and the optic chiasm. (Montgomery,2011).

Ischemic anterior optic neuropathy usually causes a loss of vision that may be sudden or occur over several days. Ischemic posterior optic neuropathy is uncommon, and the diagnosis depends largely upon exclusion of other causes, chiefly stroke and brain tumor. (Montgomery, 2011).

2.3.7 Optic atrophy:

"Optic atrophy" of the optic disc (visible to an eye doctor looking inside the eye) is the result of degeneration of the nerve fibers of the optic nerve and optic tract. It can be congenital (usually hereditary) or acquired. (Montgomery,2011).

In a normal optic disc, a large bulge of nerve fibre is formed. In enucleated glaucomatous eyes, the optic disc is obviously cupped and shrinks down to the lamina cribrosa, which becomes bowed posteriorly. Reactive fibrovascular tissue fills the cupped disc. .(Cardesa, et al 2006)

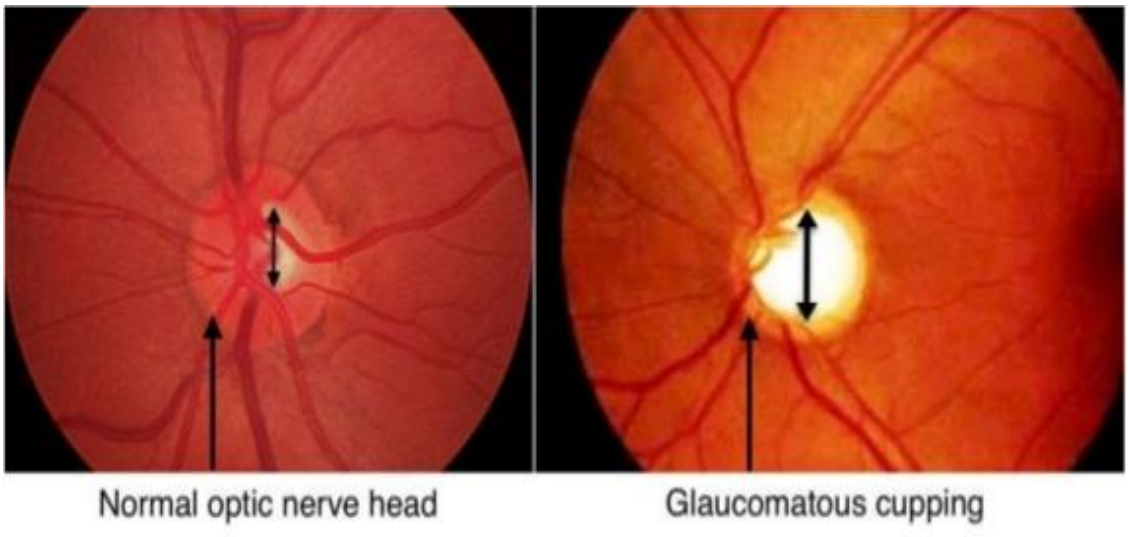


Figure 2.9: shows look at optic discs with a direct ophthalmoscope, normal disc in left and cupped disc in rigt
https://www.slideshare.net

2.3.8 Optic neuritis:

Optic neuritis presents as acute, unilateral and painful vision loss. It can result from inflammatory disorders, can occur as isolated inflammation, or may be part of the spectrum of multiple sclerosis. Magnetic resonance imaging is indicated to rule out compressive optic neuropathy. Secondary inflammatory optic neuritis (infection, vasculitis, sarcoidosis) is rare and usually presents with atypical evolution or other symptoms.

Histologically, the optic nerve in multiple sclerosis will show a perivascular lymphocytic infiltrate with focal areas of demyelination and axonal atrophy at the end stage. (Cardesa, et al 2006)

2.3.9 Lesions of the visual pathway:

Lesions of the visual pathways at level 1\ Optic nerve; 2\ proximal part of optic nerve; 3\ Central chiasma; 4\ Lateral chiasma (both side); 5\ Optic tract; 6\ Geniculate body ; 7\ Part of optic radiation in temporal lobe; 8\ Part of optic radiations in parietal lobe; 9\ Optic radiation; 10\ Visual cortex the macula; 11\ Visual cortex,only macula. (Khurana, 2006)

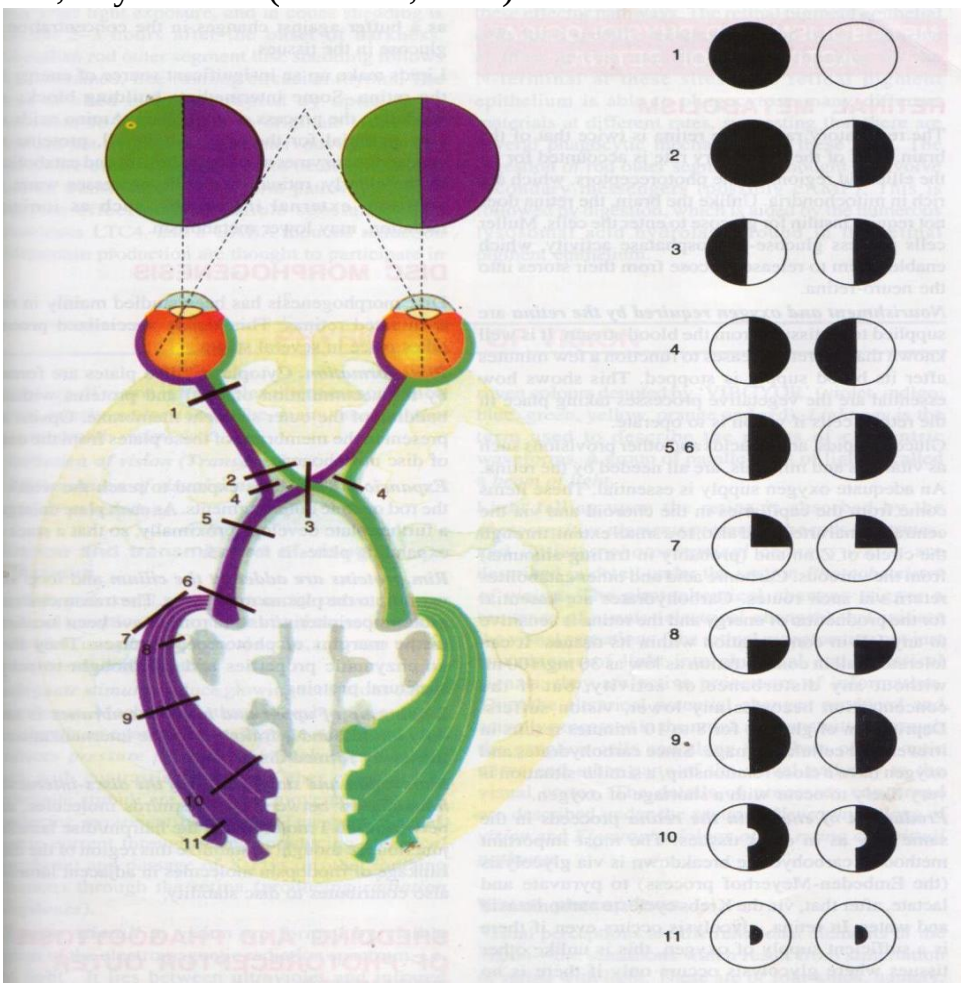


Figure 2.10 shows the lesions effects of the visual pathway (A K Khurana, 2006)

2.3.10 Diabetes mellitus (DM):

Diabetes, also referred to as diabetes mellitus, is a condition in which the body is unable to properly regulate blood sugar levels.

Diabetes is not a single disease but the pathological and metabolic state caused by inadequate insulin action: a feature common to all types is glucose intolerance.

Hyperglycemia refers to abnormally high blood sugar levels and this occurs when there is not enough insulin in the body. (MacSween, 2001)

2.3.10.1Types of Diabetic:

There are two types of diabetic:

Types 1 diabetes: which is also called juvenile or insulin dependent diabetes, develops due to the loss of cells in the pancreas that are responsible for producing insulin. This causes either no insulin or miniscule amounts to be produced. Type 1 diabetes is also commonly referred to as juvenile diabetes because it is often diagnosed during childhood (MacSween, 2001); however, it can occur in adults aged 30 – 40 years. Symptoms of type 1 diabetes may come on quickly.

The eye problem in these types of diabetes occurs in 75% to 95% of adults who have had diabetes for more than 15 years. Diabetic retinopathy in type 1 diabetes is extremely rare before puberty no matter how long they have had the disease. Medical conditions such as good control of sugars, management of hypertension and regulation of blood lipids are important to prevent retinopathy. Fortunately, the vision loss isn't significant in most people with the condition.

Types 2 diabetes, which is the most common form, develops as a result of the body's inability to properly use insulin. This inappropriate response is referred to as insulin resistance. Initially the pancreas begins to produce extra insulin in order to counteract the body's resistance, but eventually the pancreas cannot produce the amount of insulin that is needed to maintain normal blood sugar levels.

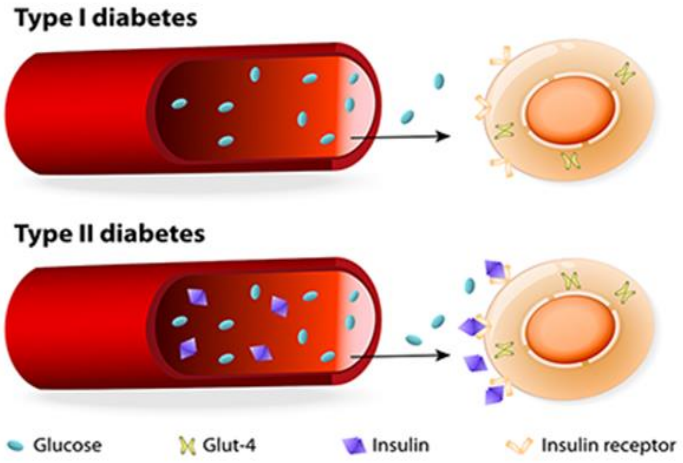


Figure 2.11 Shows the Types of diabetic
https://www.diabetes-children.ca

2.3.10.2 Diagnosis of Diabetes:

Diabetes mellitus is characterized by recurrent or persistent hyperglycemia, and is diagnosed in is the laboratory investigations:

Plasma glucose to confirm diagnosis.

Urine examination for ketonuria in type 1. If the test is positive, metabolic acidosis should be excluded.

C-peptide: Normal or high value indicates type 2, while low or immeasurable value indicates insulin deficiency (e.g. type 1).

Fasting plasma glucose level greater than 7.8 mmol\l (140mg\dl) or a 2 – hour post – prandial plasma glucose greater than 11 mmol\l (200mg\dl), after a 75g oral glucose load as in a test.

According to the current definition, two fasting glucose measurement above 126mg/dL (7.8mmol/L) is considered diagnostic for diabetic mellitus. (MacSween, 2001).

2.3.10.3 Management of Diabetes:

There is no cure for diabetes, but it can be treated and controlled. The goals of managing diabetes are to: Keep the blood glucose levels as near to normal as possible by balancing food intake with medication and activity, maintain the blood cholesterol and triglyceride (lipid) levels as near the normal ranges as possible by decreasing the total amount of fat to 30% or less of your total daily calories, and by reducing saturated fat and cholesterol, control the blood pressure. (Blood pressure should not go over 130/80.) And decrease or possibly prevent the development of diabetes-related health problems. (Ali, 2016).

2.3.10.4 Complications of Diabetes:

2.3.10.4.1 Diabetic Ketoacidosis

Diabetic ketoacidosis (DKA) is an acute medical emergency and dangerous complication that is due to Low insulin levels .the liver shift to fat metabolism by ketosis; ketone bodies are generated as intermediate substrates here. This is normal when periodic, but can become a serious problem if sustained. Elevated levels of ketone bodies in the blood decrease its pH, leading to DKA. The patient in DKA is typically dehydrated, has rapid, deep breathing. Abdominal pain is common and may be severe. The patient is typically conscious until late, when lethargy may progress to coma. Ketoacidosis can easily become severe enough to cause hypotension, shock, and death. Urine analysis will reveal significant levels of ketonuria. Prompt, proper treatment usually results in full recovery, though death can occur due to inadequate or delayed treatment, or brain edema. DKA is more common in type 1 diabetes. (Adler et al.2000).

2.3.10.4.2 Hyperglycemia Hyperosmolar State

Hyperosmolar nonketotic state (HNS) is an acute complication sharing many symptoms with DKA, but an entirely different origin and different treatment. A patient with very high (usually above 300 mg/dl (16 mmol/L)) blood glucose levels has high osmotic effect that cause water to be drawn out of cells into the blood and the kidneys eventually begin to pass glucose into the urine. This results in loss of water and further increase in blood osmolarity. If fluid is not replaced (by mouth or intravenously), this osmotic effect, combined with water loss, will eventually lead to dehydration. The cells become progressively dehydrated. Electrolyte imbalances are also common and are always dangerous. As with DKA, urgent medical treatment is necessary, commonly beginning with fluid volume replacement. Lethargy may ultimately progress to a coma, though this is seen in type 2 diabetes. (Ali,et al 2016).

2.3.10.4.3 Hypoglycemia

Hypoglycaemia is a common complication of drug treatment and is a particular risk in insulin-treated patients. Severe episodes can lead to serious complications and may be potentially fatal if left untreated. (Ali,et al 2016).

Hypoglycaemia is a medical emergency and should always be treated promptly; Blood glucose should be measured, using glucose-sensitive reagent strips to confirm the diagnosis in suspected cases. But if this measurement is not immediately available, treat as hypoglycaemia. (Ali,et al 2016).

2.3.10.4.4 Diabetic Coma

Diabetic coma is a medical emergency in which diabetic patient is comatose due to acute complications of diabetes like: Severe hypoglycemia, severe DKA due to combination of severe hyperglycemia, dehydration and shock, and exhaustion. Or Hyperosmolar nonketotic coma in which extreme hyperglycemia and dehydration are sufficient to cause coma. (Adler et al.2000).

2.3.10.4.5 Diabetic Neuropathy:

Diabetic neuropathy is recognized the presence of symptoms and/or signs of peripheral nerve dysfunction in people with diabetes after the exclusion of other causes. As with other microvascular complications, risk of developing diabetic neuropathy is proportional to both the magnitude and duration of hyperglycemia, and some individuals may possess genetic attributes that affect their predisposition to developing such complications.

The precise nature of injury to the peripheral nerves from hyperglycemia is not known but likely is related to mechanisms such as polyol accumulation, injury from AGEs, and oxidative stress. Peripheral neuropathy in diabetes may manifest in several different forms, including sensory, focal/multifocal, and autonomic neuropathies.

Diabetic autonomic neuropathy also causes significant morbidity and even mortality in patients with diabetes. Neurological dysfunction may occur in most organ systems and can by manifest by gastroparesis, constipation, diarrhea, anhidrosis, bladder dysfunction, erectile dysfunction. Treatment of autonomic neuropathy is targeted toward the organ system that is affected, but also includes optimization of glycemic control. (Michael, 2008).

2.3.10.4.6 Diabetic Retinopathy:

Diabetic retinopathy may be the most common microvascular complication of diabetes. It is responsible for ~ 10,000 new cases of blindness every year in the United States alone. The risk of developing diabetic retinopathy or other microvascular complications of diabetes depends on both the duration and the severity of hyperglycemia.

Diabetic retinopathy is generally classified as either background or proliferative. It is important to have a general understanding of the features of each to interpret eye examination reports and advise patients of disease progression and prognosis, Background retinopathy includes such features as small hemorrhages in the middle layers of the retina. They clinically appear as “dots” and therefore are frequently referred to as “dot hemorrhages.

Proliferative retinopathy is characterized by the formation of new blood vessels on the surface of the retina and can lead to vitreous hemorrhage. White areas on the retina (“cotton wool spots”) can be a sign of impending proliferative retinopathy. If proliferation continues, blindness can occur through vitreous hemorrhage and traction retinal detachment. With no intervention, visual loss may occur. Laser photocoagulation can often prevent proliferative retinopathy from progressing to blindness; therefore, close surveillance for the existence or progression of retinopathy in patients with diabetes is crucial. (Michael, 2008)

To prevent retinopathy and visual loss, the following are recommended:

Promoting good glycaemic control in all diabetic individuals, controlling blood pressure, detecting and treating glaucoma at an early stage, detecting and treating

cataract and detecting and providing timely treatment of potentially serious retinal changes. (Alwan, 1994).

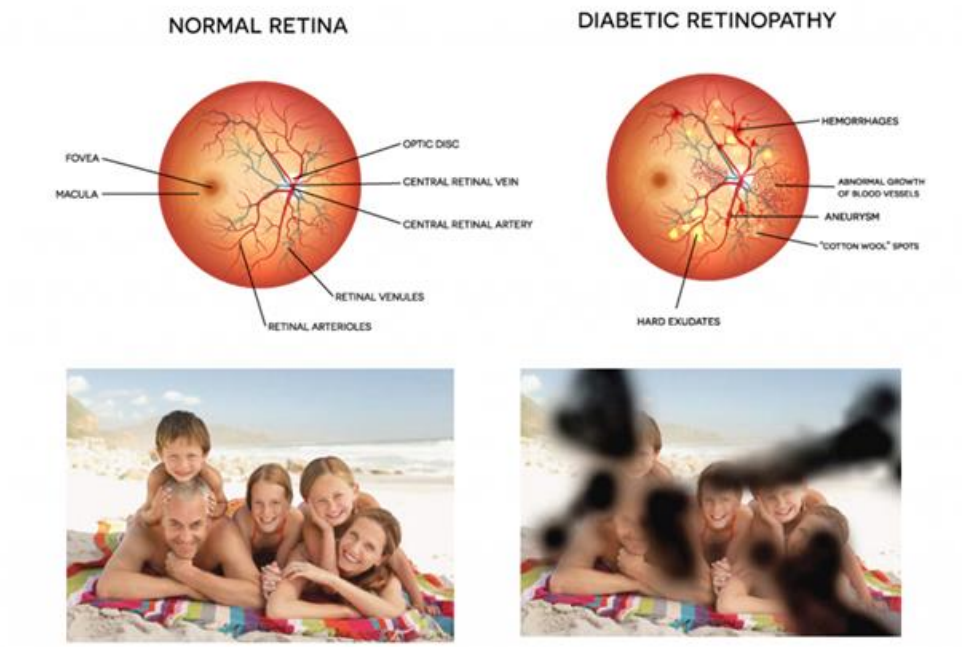


Figure: 2.12 Shows comparison between normal eye and eye with diabetic retinopathy

http://reachoutradio.org

2.4 Orbital Imaging Technique:

2.4.1 Ophthalmoscopy:

Good ophthalmoscopy is essential to avoid missing many serious ocular and general diseases. A direct ophthalmoscope can be used to allow intraocular structures to be seen. Specific contact and non-contact lenses are used during the examination, and the ophthalmologist should use a slit-lamp microscope or head-mounted ophthalmoscope.

The direct ophthalmoscope should be set on the "0" lens. The patient should be asked to fix their gaze on an object in the distance, as this reduces pupillary constriction and accommodation, and helps keep the eye still. To enable a patient to fix on a distant object with the other eye, the examiner should use his right eye to examine the patient's right eye, and vice versa.

The optic disc should then be located and brought into focus with the lenses in the ophthalmoscope. The retina should be scanned for abnormalities such as haemorrhages, exudates, or new vessels. The green filter on the ophthalmoscope

helps to enhance blood vessels and microaneurysms. Finally the macula should be examined (Khaw, 2004).

2.4.2 Transorbital sonography:

A high – resolution 7.5 MHz or higher linear array ultrasound transducer is used to perform an ocular examination.

Large amount of standard water – soluble ultrasound transmission gel should be applied to the patient's closed eyelid so that the transducer doesn't have to touch the eyelid.

The patient was examined in supine position asked to look straight ahead with eye closed, but without clenching the eyelid.

The evaluation of the optic nerve sheath diameter is a simple noninvasive procedure, which is useful tool in the assessment of elevated intracranial pressure, and pepilledema.

The ONSD is measured 3mm posterior to the globe for both eyes. Sonographic ONSD quantification 3 mm behind the papilla can be performed with good reproducibility, measurement accuracy and observer agreement. Thus, our findings emphasize the feasibility of this technique as a non-invasive bedside tool for longitudinal ONSD measurements. (Sirkar , et al 2008)

Figure: 2 .13 A high – resolution linear array ultrasound transducer, perform an ocular examination.

https://www.acep.org

2.4.3 Orbital CT Technique:

2.4.3.1 Indications:

Structural diseases of the orbits and orbital contents, trauma and foreign body. (Henwood, 1999)

Visualization of entire orbit, osseous walls. (Henwood, 1999)

2.4.3.2 Patient Technique:

Supine for axial scan; supine or prone for coronal scans.

Volume of investigation: from 0.5cm below to 0.5cm above the orbital cavity

Lateral scout view is obtained. (Henwood, 1999)

Gantry tilt: 6 – 10 degree from OM or parallel to optic nerve for axial scan according to the patient position for coronal scanning or x-ray beam parallel to the IOML. (Henwood, 1999)

2.4.3.3 Axial scan:

Axial scan should cover all orbital regions.

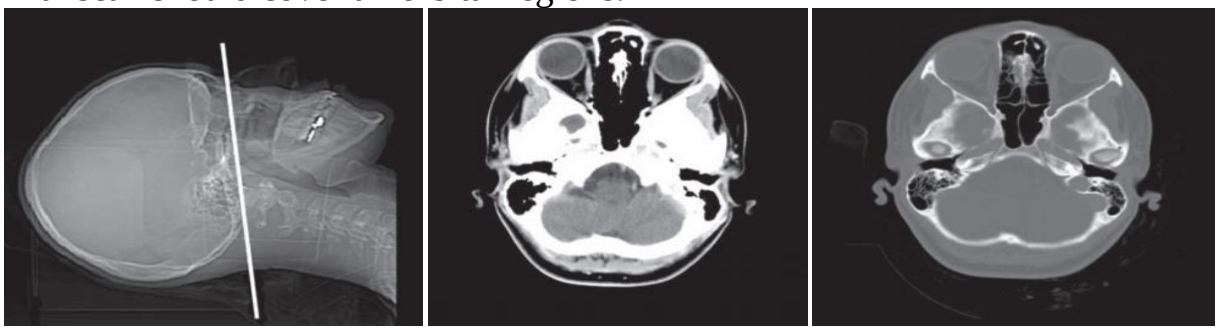


Figure 2.14 shows the axial CT scan

(Romans, 2011)

Slice thickness 2 – 5 mm. Feed 2 – 5 mm.

Some institutions prefer to use 1mm axial slices with reformatting to produce coronal images. This technique is useful coronal images cannot obtain; however, reformatted images tend to be of poor quality. (Henwood, 1999)

2.4.3.4 Coronal scan:

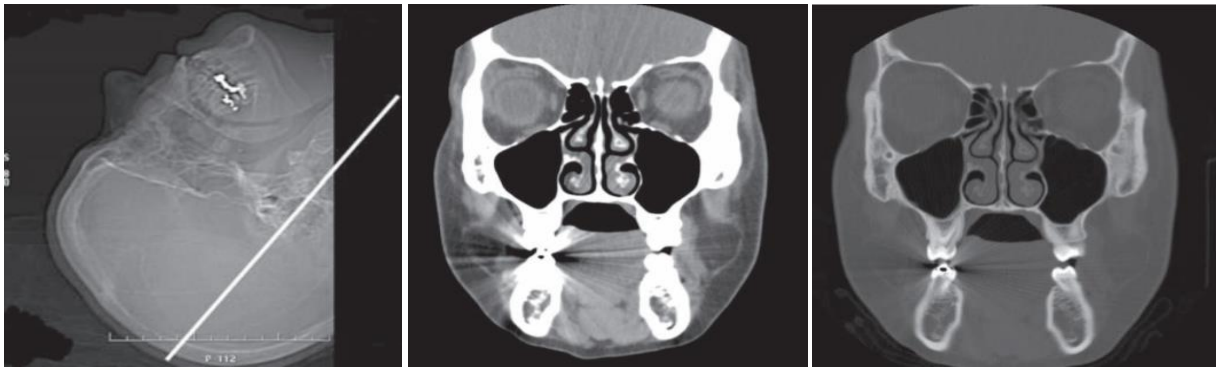


Figure 2.15 shows the coronal supine CT scan

(Romans, 2011)

Patients' supine**,** head rest in coronal holder, with neck hyper extended.

Lateral scout view is obtained; Coronal scan should cover all orbital regions.

Slice thickness 2 – 5mm, spacing 2 – 5 mm. (Henwood, 1999)

2.4.3.5 Coronal prone:

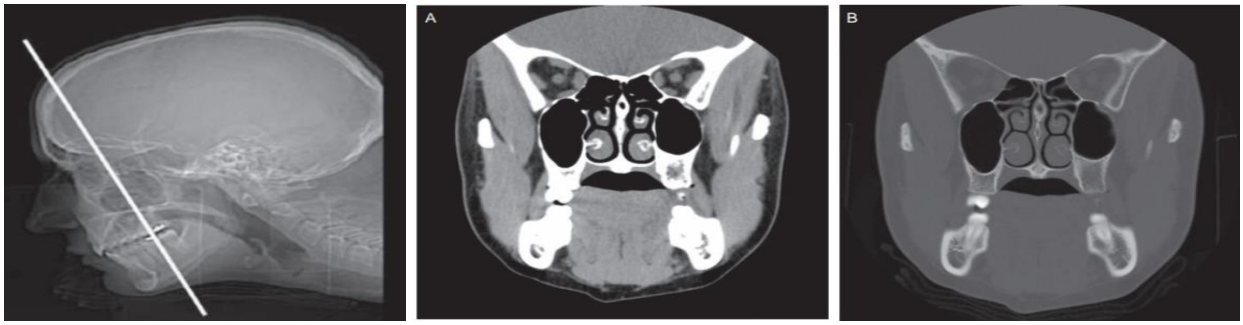


Figure 2.16 shows the coronal prone CT scan
(Romans, 2011)
Slice thickness 2 – 5 mm. Feed 2 – 5 mm. (Henwood, 1999)

2.4.4 Orbital MRI Technique:

2.4.4.1 Common indications:

Proptosis
Visual disturbance
Evaluation of orbital or ocular mass lesion (Westbrook, 2008)

2.4.4.2 Equipment:

Small surface coil for globe and orbit, Quadrature head coil or multi-coil array coil for orbital apex, chiasm and intracranial optic pathway, Immobilization straps and foam pads, Ear plugs. (Westbrook, 2008)

2.4.4.3 Patient positioning:

The patient lies supine on the examination couch. Both orbits are usually examined at the same time. If surface coil are used, these are placed over –each orbit but should not touch the patient. Special holders are often provided by the manufactures to enable the coils to be placed anteriorlly over the eyes. Ensure that the receiving side of the coil. (Westbrook, 2008)

Is faces the orbits, i.e. toward the table. The patient assumes a fixed gaze, straight ahead, with eye open. This enables the patient to focus and keeps the eyes still. There by reducing motion artifact. Any eye make – up is removed prior the examination as this causes image artifact and patient discomfort especially if it contains metal.

The patient is positioned so that the longitudinal alignment light lies in the midline, and the horizontal alignment light passes through the orbits. If surface coils are used, this corresponds to the centre of the coils. Straps and foam pads are used for immobilization. (Westbrook, 2008)

2.4.4.4 Suggested protocol:

Axial SE T1

Sagittal SE T2

Coronal SE T1

Note, if optic neuritis is suspected scan the brain. (Westbrook, 2008)

Figure 2.17 shows the MRI head coil for orbital scan
https://mrimaster.com

Figure 2.18 shows the positioning of the standard head coil and the two orbit surface coils
https://www.researchgate.net

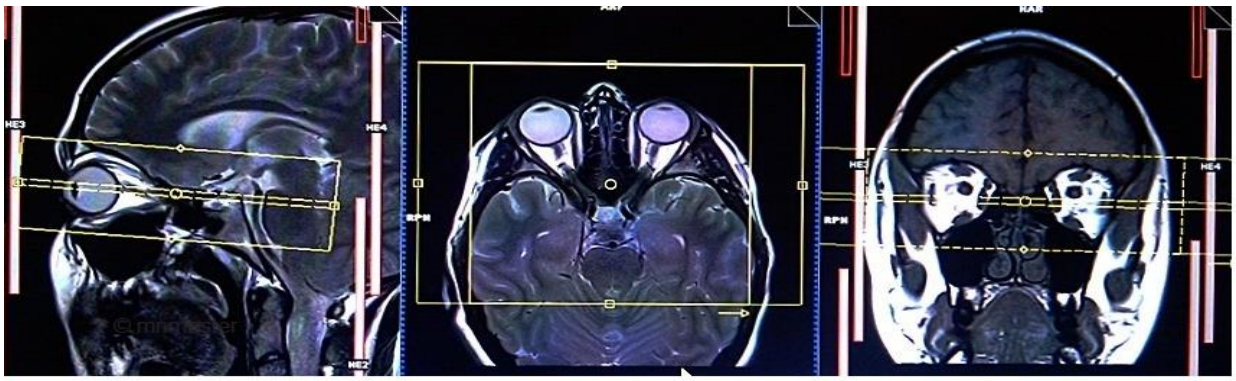


Figure 2.19 shows the T2 Stir axial localizer
https://mrimaster.com

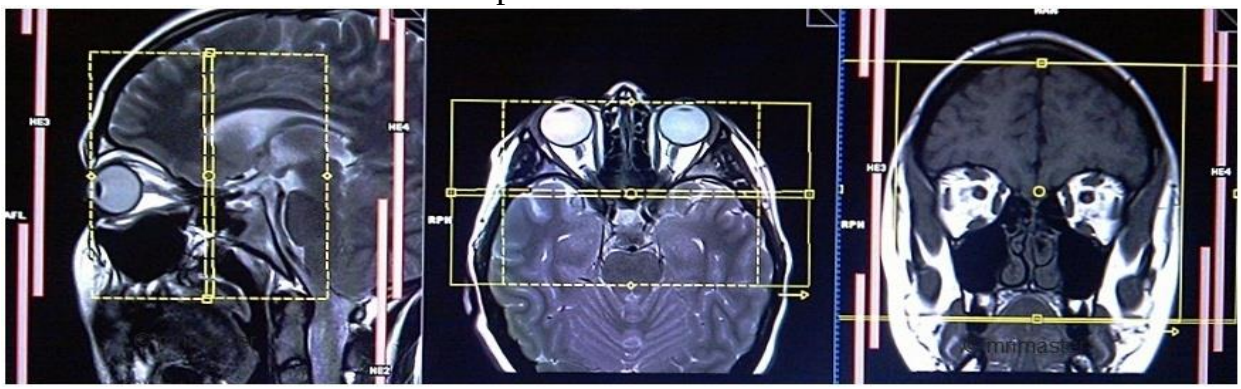


Figure 2.20 Shows the T2 stir coronal 3mm localizer
https://mrimaster.com

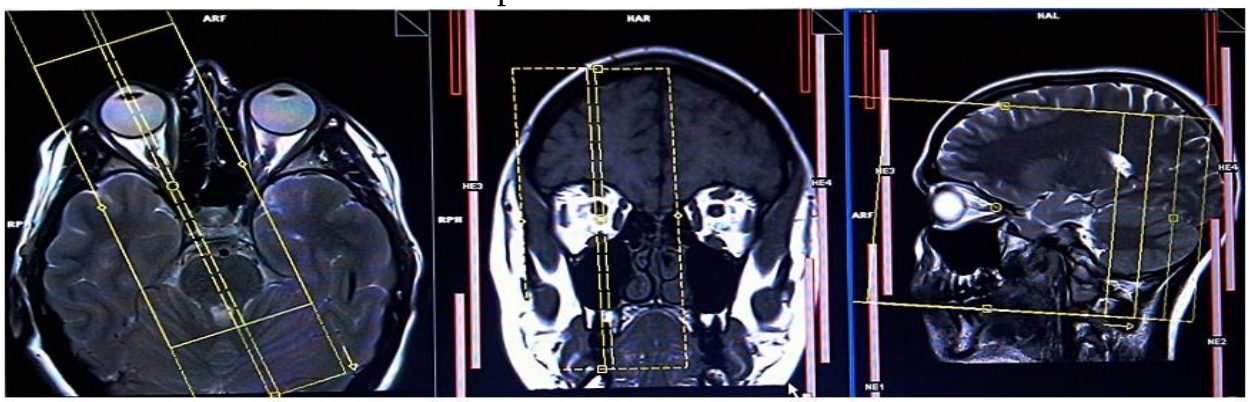


Figure 2.21 shows the sagittal oblique RT localizer
https://mrimaster.com

2.5 Magnetic Resonance Imaging System:

The MRI system consists of several major components; the heart of the MRI system is a large magnet that produces a very strong magnetic field. The patient's body is placed in the magnetic field during the imaging procedure. The magnetic field produces two distinct effects that work together to create the image.

When the patient is placed in the magnetic field, the tissue becomes temporarily magnetized because of the alignment of the protons; this is a very low-level effect that disappears when the patient is removed from the magnetic field. The ability of MRI to distinguish between different types of tissue is based on the fact that different tissues, both normal and pathologic, will become magnetized to different levels or will change their levels of magnetization (i.e., relax) at different rates.The magnetic field also causes the tissue to "tune in" or resonate at a very specific radio frequency. That is why the procedure is known as magnetic resonance imaging. (Sprawls, 2000)

The general characteristics of a typical magnetic field. At any point within a magnetic field, the two primary characteristics are field direction and field strength. (Sprawls, 2000)

There are several different types of magnets that can be used to produce the magnetic field. Each has its advantages and disadvantages. (Sprawls, 2000)

The gradients are produced by a set of gradient coils, which are contained within the magnet assembly. During an imaging procedure the gradients are turned on and off many times. This action produces the sound or noise that comes from the magnet. (Sprawls, 2000)

Shimming one of the requirements for good imaging is a homogeneous magnet field. This is a field in which there is uniform field strength over the image area. Shimming is the process of adjusting the magnetic field to make it more uniform.

Inhomogeneities are usually produced by magnetically susceptible materials located in the magnetic field. (Sprawls, 2000)

The external magnetic field surrounding the magnet is the possible source of two types of problems. One problem is that the field is subject to distortions by metal objects (building structures, vehicles, etc.). These distortions produce inhomogeneities in the internal field. The second problem is that the field can interfere with many types of electronic equipment such as imaging equipment and computers. (Sprawls, 2000)

It is a common practice to reduce the size of the external field by installing shielding. There are two types of shielding: *passive* and *active*.

Passive Shielding; Passive shielding is produced by surrounding the magnet with a structure consisting of relatively large pieces of ferromagnetic materials such as iron. (Sprawls, 2000)

Active Shielding; Active shielding is produced by additional coils built into the magnet assembly. They are designed and oriented so that the electrical currents in the coils produce magnetic fields that oppose and reduce the external magnetic field. (Sprawls, 2000)

The radio frequency (RF) system provides the communications link with the patient's body for the purpose of producing an image.

The MRI process uses RF signals to transmit the image from the patient's body. The RF energy used is a form of non-ionizing radiation. The RF pulses that are applied to the patient's body are absorbed by the tissue and converted to heat. A small amount of the energy is emitted by the body as signals used to produce an image. Actually, the image itself is not formed within and transmitted from the body. The RF signals provide information (data) from which the image is reconstructed by the computer. However, the resulting image is a display of RF signal intensities produced by the different tissues. (Sprawls, 2000)

The RF coils are located within the magnet assembly and relatively close to the patient's body. These coils function as the antennae for both transmitting signals to and receiving signals from the tissue. There are different coil designs for different anatomical regions. The three basic types are body, head, and surface coils.

A digital computer is an integral part of an MRI system. The production and display of an MR image is a sequence of several specific steps that are controlled and performed by the computer. (Sprawls, 2000)

The first step is the acquisition of the RF signals from the patient's body. This acquisition process consists of many repetitions of an imaging cycle. During each cycle a sequence of RF pulses is transmitted to the body, the gradients are activated, and RF signals are collected. Unfortunately, one imaging cycle does not produce enough signal data to create an image. Therefore, the imaging cycle must be repeated many times to form an image. The time required to acquire images is determined by the duration of the imaging cycle or cycle repetition time—an adjustable factor known as TR—and the number of cycles. The number of cycles used is related to image quality. Protocols stored in the computer control the acquisition process. The operator can select from many preset protocols for specific clinical procedures or change protocol factors for special applications.

The RF signal data collected during the acquisition phase is not in the form of an image. However, the computer can use the collected data to create or "reconstruct"

an image. This is a mathematical process known as a Fourier transformation that is relatively fast and usually does not have a significant effect on total imaging time.
The reconstructed images are stored in the computer where they are available for additional processing and viewing. The number of images that can be stored—and available for immediate display—depends on the capacity of the storage media.
The computer is the system component that controls the display of the images. It makes it possible for the user to select specific images and control viewing factors such as windowing (contrast) and zooming (magnification). (Sprawls, 2000)

Figure 2.22 shows the Magnetic Resonance Imaging System
https://www.tebtime.com

2.4.4.5 MR Imaging Findings:

A number of studies have used imaging techniques to investigate the anatomic changes of the ON. Of the many imaging techniques, MR imaging has been of particular interest because of its ability to provide gross visualization of the optic globe, ON, orbits, and optic tract. Additionally, MR imaging provides higher soft-tissue contrast and free section orientation capabilities compared with CT and appears to be more accurate in assessing the ON than sonography. (Passi, et al, 2013)
Despite these advantages, the ON has been technically difficult to image because of its small size: It is 0.4–0.6 cm in diameter within the orbit. T2-weighted FSE sequences with fat-suppression have been found to be optimal for visualizing the

ONs and perioptic CSF. Coronal image acquisitionis optimal for visualizing the true dimensions of the ON and perioptic CSF relative to the surrounding sheath. (Passi, et al, 2013)

High-resolution MRI is accurate at measuring ONSD and OND and has been proposed to detecting the measurement.

On T2-weighted sequences, water (and CSF) exhibits a high signal (white). Fat and grey matter appears as light grey and white matter as dark grey.

The perioptic CSF is surrounded by orbital fat. Contrast between CSF and orbital fat can be improved with fat suppression, increasing the image resolution for the ONSD measurement.

The ONS is widest anteriorly behind the globe and narrowed toward the orbital apex; these dimensions are consistent with the results of a histological study of the ON. The sheath of the ON behind the globe is the most distensible part of the ONS, giving it a bulbous appearance. (Passi, et al, 2013).

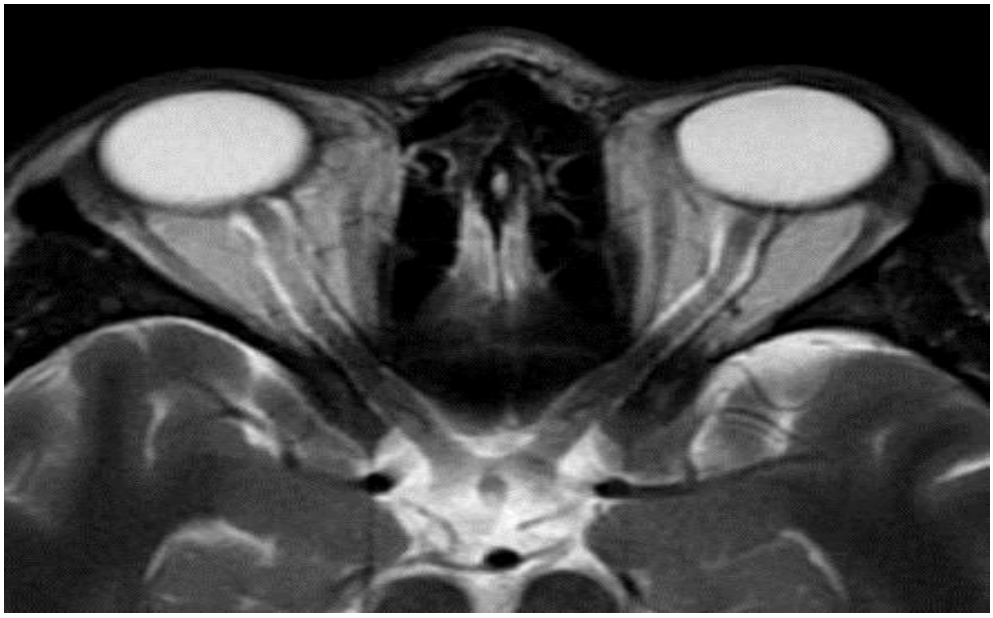


Figure: 2.23 Shows axial MRI STIR for Optic Nerve and Chiasm
https://radiopaedia.org

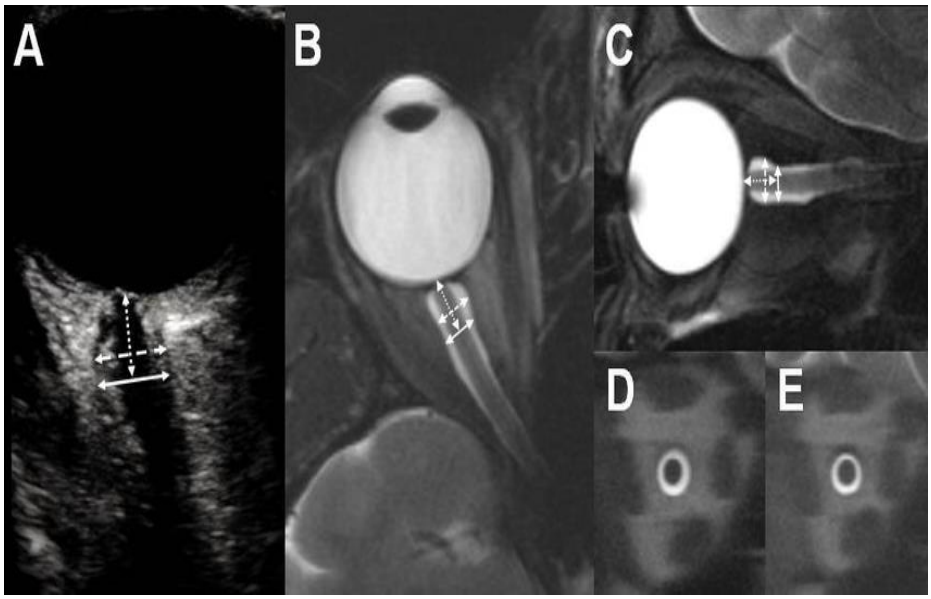


Figure: 2. 24 Shows transbulbar sonography and MRI of the optic nerve sheath. https://www.researchgate.net

2.2 Previous Studies:

Altayib, Niam Nadir Alzain, et al 2015 had studied Measurement of the Optic nerve in diabetic patient using magnetic resonance imaging MRI, The main objective of their study is to measure the Optic Nerve in diabetic patient using MRI. The study was carried out during the period from June to November 2014 at Garash international hospital. The total sample under study were 50 (30 of them had diabetes and 20 as control group in both genders) there ages between 30 – 90 years old. All sample were examed in coronal and sagittal cuts where measure of widths and length of the optic nerve. The measurements are correlation with patients ages and duration of diabetes. The coronal measurement of the optic nerve in diabetic patient group were decreased by 0.006 as the age increased and From the sagittal measurement of the optic nerve in diabetic patient group when decreased by 0.001 as the age increased with is mean the patient age effect the optic nerve diameter in widths and length . The coronal measurement of the optic nerve in diabetic patient group were decreased by 0.009 as the duration of diabetic increased and From the sagittal measurement of the optic nerve in diabetic patient group when decreased by 0.002 as the duration of diabetic increased and that is mean when the duration of diabetic increased the measurements of the optic nerve decreased. MRI has great value in measurements of the optic nerve diabetic Patient.

S. Manimala Rao, et al 2015 had studied Correlation of measurement of optic nerve sheath diameter using ultrasound and magnetic resonance imaging. techniques in order to establish the accuracy of ocular sonography as a noninvasive modality for detecting raised intracranial pressure (ICP), they ruslts the mean ONSD values measured with ultrasonography (USG) and MRI for female were 5.48 ± 0.43 mm and 5.68 ± 0.44 mm and for male were 5.40 ± 0.37 mm and 5.56 ± 0.38 mm, respectively. The mean age of the female and male was 53.90 ± 17.84 and 56.06 ± 15.67 years, respectively. On comparing ultrasound with MRI-derived ONSD values, we found acceptable agreement between both methods for measurements at a depth of 3 mm ($r = 0.02$, $P < 0.001$).

Michael Vaiman,et al 2015 had studied Optic nerve sheath diameters in healthy adults measured by computer tomography, To measure optic nerve sheath diameters (ONSD) in different locations by computer tomography (CT) and to recommend the best location for cases when ONSD is used for intracranial pressure monitoring. The right/left ONSD are 4.94±1.51/5.17±1.34 mm at 3 mm, 4.35±0.76/4.45±0.62 mm at 8 mm from the globe, and 3.55±0.82/3.65±0.7 mm at 3 mm from the optic canal. No significant differences correlated with gender of the patients, their age, and ethnic background was found. In healthy persons, the ONSD varies from 5.17±1.34 mm to 3.55±0.82 mm in different locations within the intraorbital space. The most stable results with lesser standard deviation can be obtained if it is measured 8-10 mm from the globe.

Foram Gala, 2015 had studies Magnetic resonance imaging of optic nerve and they Optic nerves are the second pair of cranial nerves and are unique as they represent an extension of the central nervous system. Apart from clinical and ophthalmoscopic evaluation, imaging, especially magnetic resonance imaging (MRI), plays an important role in the complete evaluation of optic nerve and the entire visual pathway. In this pictorial essay, the authors describe segmental anatomy of the optic nerve and review the imaging findings of various conditions affecting the optic nerves. MRI allows excellent depiction of the intricate anatomy of optic nerves due to its excellent soft tissue contrast without exposure to ionizing radiation, better delineation of the entire visual pathway, and accurate evaluation of associated intracranial pathologies.

A.J. Degnan, et al 2012 had studies MR Imaging of Papilledema and Visual Pathways: Effects of Increased Intracranial Pressure and Pathophysiologic Mechanisms.

Papilledema, defined as swelling of the optic disc, frequently occurs in the setting of increased ICP and in a variety of medical conditions, including pseudotumor cerebri, sinus thrombosis, intra cerebral hemorrhage, frontal lobe neoplasms, and Chiari malformation. Non invasive imaging of the ON is possible by using MR imaging, with a variety of findings occurring in the setting of papilledema, including flattening of the posterior sclera, protrusion of the optic disc, widening of the ONS, and tortuosity of the ON. Early recognition of papilledema and elevated ICP is of paramount importance for ensuring restoration of vision. Newer advanced MR imaging techniques such as MRI and DTI may prove useful in the future to assess the potential effects of papilledema on retinal and visual pathway integrity. The SAS around the ON in the orbit can be observed by using T2-weighted MR imaging with fat-saturation pulse sequences. The ONS diameter can be evaluated by measuring the outer diameter of the SAS. The normal ONS diameters just behind and 4 mm posterior to the globe are 5.52 ±1.11 and 5.2 ± 0.9 mm.

S.S. Hayreh, 2011 had studies Ischemic Optic Neuropathies: Structure of the Optic Nerve it's the length of the optic nerve varies widely, even between the two eyes of the same person and is 35–55 mm from the eyeball to the chiasma (intraocular part 1 mm, intraorbital part 25 mm, intracanalicular part 4–10 mm and intracranial part 10 mm).

Wolf A. Lagrèze, et al 2009 had studied Retrobulbar Optic Nerve Diameter Measured by High-Speed Magnetic Resonance Imaging as a Biomarker for Axonal Loss in Glaucomatous Optic Atrophy, the purpose of their study to assess a novel magnetic resonance imaging (MRI) protocol for quantifying the optic nerve diameter (OND) as a measure of axonal loss in the optic nerve. Included in the study was one eye each from 47 subjects, of whom 9 had no eye disease, 16 had preperimetric glaucoma, 11 had a glaucomatous mean visual field defect of <10 dB and 11 of >10 dB. Each subject underwent automated perimetry, scanning laser polarimetry, optic coherence tomography, scanning laser tomography, and ultrafast high-resolution MRI at 3 T. OND was determined 5, 10, and 15 mm behind the eye with a half Fourier-acquired single-shot turbo spin-echo (HASTE)-sequence requiring 1.5 seconds of data acquisition time per slice and providing a spatial resolution of 0.11 mm. A multiple linear regression model was applied to determine correlations (*r*) among the different techniques. The results of their study the correlation (*r*) was <0.37 for OND measurements taken 5 mm behind the

eye. At 10 mm behind the eye, *r* increased to 0.57 and was statistically significant in four out six instances. In the orbital apex 15 mm behind the eye, *r* reached a maximum of 0.80 and was statistically significant in all instances. OND correlated best with the retinal nerve fiber layer thickness measured by optic coherence tomography. Their conclusions the retina- or optic nerve head–related surrogate markers for axonal content correlated closely with the OND, although only when it was measured in the orbital apex. High-resolution MRI using an ultrafast HASTE-sequence at 3 T proved useful for OND quantification and may be a valuable asset in future neuroprotection trials.

Thomas Geeraerts, et al 2008 had studies Use of T2-weighted magnetic resonance imaging of the optic nerve sheath to detect raised intracranial pressure and they results the measurement of ONSD was possible in 95% of cases. The ONSD was significantly greater in TBI patients with raised ICP (>20 mmHg; 6.31 ± 0.50 mm, 19 measures) than in those with ICP of 20 mmHg or less (5.29 ± 0.48 mm, 26 measures; $P < 0.0001$) or in healthy volunteers (5.08 ± 0.52 mm; $P < 0.0001$). There was a significant relationship between ONSD and ICP ($r = 0.71$, $P < 0.0001$). Enlarged ONSD was a robust predictor of raised ICP (area under the receiver operating characteristic curve = 0.94), with a best cut-off of 5.82 mm, corresponding to a negative predictive value of 92%, and to a value of 100% when ONSD was less than 5.30 mm.

Seung Ryu, et al 2008 had studies Utility of Optic Nerve Sheath Diameter Measured by Ultrasonography for the Detection of Increased Intracranial Pressure in Adults. There were 21 patients in group A and 70 patients in group B. The mean for binocular ONSDs in group A was 5.1+/-0.6 mm and 4.5+/-0.4 mm in group B (plt; 0.01). The CSF pressure correlated with the ONSD (Correlation Coefficient=0.54) (plt; 0.01). In the ROC curve (Receiver operating characteristic curve) for ONSD to distinguish group A from B, the AUC was 0.8 (95% confidence interval 0.7~0.9) with a sensitivity of 81.0%, and a specificity of 75.7% when the cut off value was set at 4.7 mm.

J.D. Benevento, et al 2004 studied Optic Nerve Measurements in Normal Human Eyes by MRI and they used coronal MRI imaging of normal human eyes MRI Images of 14 patients (7 males, 7 females) were reviewed. Age ranged from 36 to 78 years. Of the 28 orbits evaluated, ONSD could be measured in all cases, while OND was measurable in 19 (68% of eyes). Mean ONSD was 4.9mm (range: 4.0 – 6.0) SD 0.5mm. Mean ONSD was 5.0mm in males SD 0.6mm, and 4.9mm SD

0.5mm in females. Mean ONSD was 4.9mm SD 0.6mm in subjects younger than 50 years old, and 5.0mm SD 0.5mm in subjects 50 and over. Mean OND was 3.1mm (range: 2.6 – 4.0) SD 0.3mm. Mean OND was 3.1mm in males SD 0.2mm, and 3.1mm SD 0.5mm in females. Mean OND was 3.3mm SD 0.4mm in subjects younger than 50 years old, and 3.0mm SD 0.3mm in subjects 50 and over.There range is consistent with published data on the ONSD. However, we are not aware of any published data on the OND.

Chapter Three

Materials &Methods

Chapter Three

Material & Method

3.1 Material:

3.1.1 Study Population:

The samples of study were divided into two groups;

Group1 included fifty diabetic patients, their age from (23 – 84) years old. Who were diagnosed with diabetic disease and to be affecting with and were untreated

Group 2 included one hundred control subjects, their age from (18 – 80) years old. In control subject the patients who diagnostic diabetic and hypertension, were excluded. And the patients with diagnostic any eyes problem such as Papilledema, idiopathic intracranial hypertension...Etc was excluded.

3.1.2 Area, duration of study and data analysis:

This study was conducted in radiology department of Antalya Medical Center Hospital and Royal Care International Hospital in Khartoum, Sudan, during the period from January 2015 up to January 2018.

3.1.3 Equipments:

(General Electric (GE), USA) system, Closed magnet signa high definition (H D) with magnetic field strength 1.5 Tesla and Toshiba system 1.5 Tesla, head coil for head exam, head support pads and PACS System.

3.2 Method:

3.2.1 Examination Technique:

The patient filled out the questionnaire and removes anything containing metal (hearing aids, hair-pins, body jewelry, watch, etc).

The patient lies supine with head first on MRI examination. Both orbits were examined. Used head coil, these are placed over – each orbit but should not touch the patient. The patients were positioned so that the longitudinal alignment light lies in the midline, and horizontal alignment light passes through the orbits. Straps and foam pads were used for immobilization.

3.2.2 Protocols and Parameters:

Three plane localizer obtained to get the axial T2; this is done by ensuring sagittal localizer lines parallel to the optic nerve.

The scan parameters were as follows: repetition time 3500, echo time 86.6/Ef, slice thickness 3 mm, spacing between slices 0.0 mm, felid of view 16*16 and matrix is 320*224. The optic nerve sheath appeared as a high signal surrounding a region of low signal corresponding to the optic nerve. The axial image slice that

provided the best view of the ONSD. The retrobulbar area was zoomed to 300×, and then ONSD and OND were measured in an axis perpendicular to the optic nerve, 3 mm behind the globe using an electronic caliper. The OND and the ONSD values obtained from both sides were averaged for comparison with standard range of optic nerve.

3.2.3 Measurement:

From the PACS system, using the measurement ruler, the optic nerve thickness and length was measured.

The optic nerve sheath diameter and the optic nerve diameter were measured at 3mm just behind eyeball on an axial T2 fatsat sequence.

The length of optic nerve was measured at four step starting passes through sclera, choroid, and appears in eye as optic disc there are intraocular portion, intraorbital part; extends from back of the eyeball to the optic foramina, intracanalicular; as it passes through bony optic canal along with ophthalmic artery, and the area of the intracranial; lies above the cavernous sinus and converges with its fellow (over the diaphragma sellae) to form the chiasm were used the axial T2-weighted turbo spin-echo fat-suppressed sequence to measure optic nerve pathway.

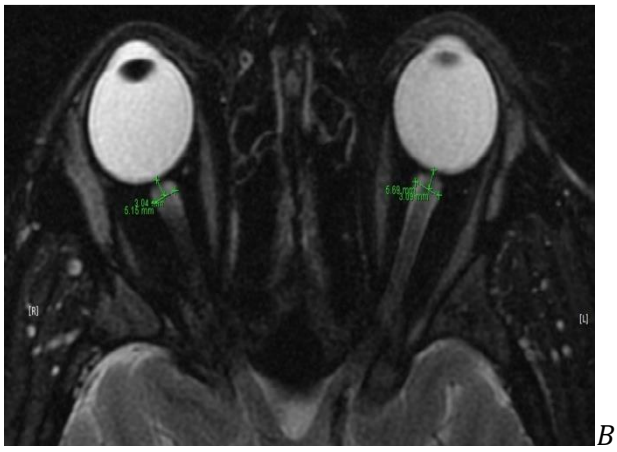
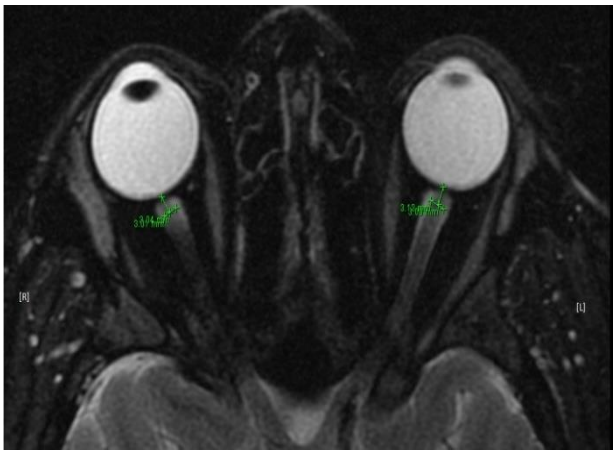
A  *B* 

Figure 3.1 Example of measurement method; axial T2-weighted FSE image demonstrates bilateral presentation of the A.ONSD 3mm behind globe, B.OND 3mm behind globe in a 25 - year-old female and the patient had no diabetic, or hypertension.

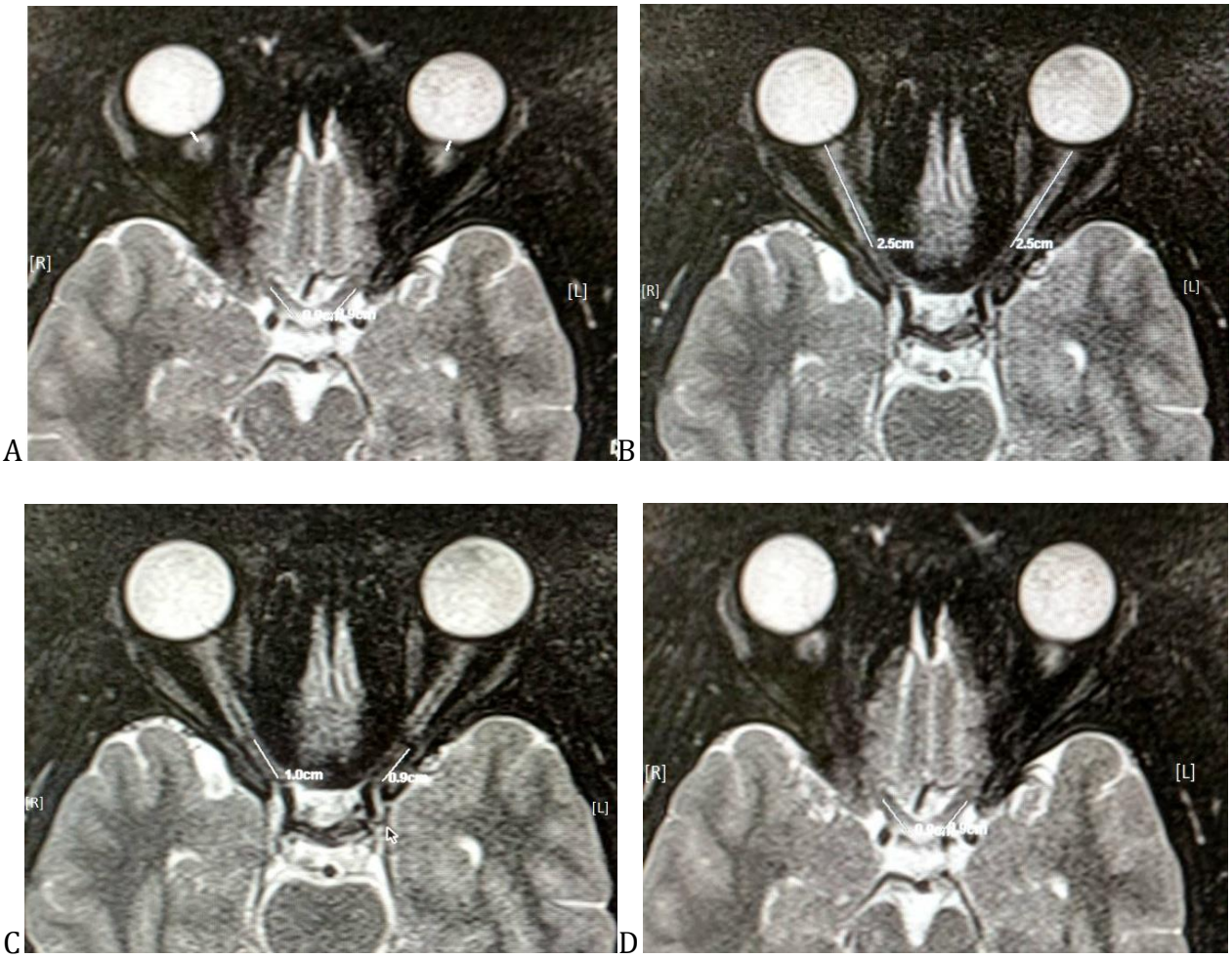


Figure 3.2 .Example of our measurement method, axial T2-weighted FSE image demonstrates bilateral presentation of the ON sheath in a 19-year-old female and the patient had no diabetic, or hypertension or any eyes problems A. the area of the ocular part B. the area of orbital part C. area of canalicular part D. area of the intracranial part

3.3 Tools:

3.3.1 Data Collection:

Questionnaire was designed containing data regarding the persona details: name, age, gender, duration of diabetic, measurement, MRI finding of both eyes.

3.3.2 Data Analysis:

Analyzed using SPSS program, version 16 the frequency and percentage, all values expressed as means ± SD, maximum value, minimum value, T- Test was used to compare means. And P value of <0.05 was considered to be statistically significant. Graphics including linear relationship and pie graph were used.

Verbal consent was taken from hospital administer, and from patients. No identification or individual details were published. No information or patient details will be disclosed or used for other than the study.

Chapter Four

Results

Chapter Four
The Results

4.1 Results:

Table (4 – 1): shows distribution of male and female frequency and percentage in diabetic patients.

	Frequency	Percentage
Male	26	52%
Female	24	48%
Total	50	100%

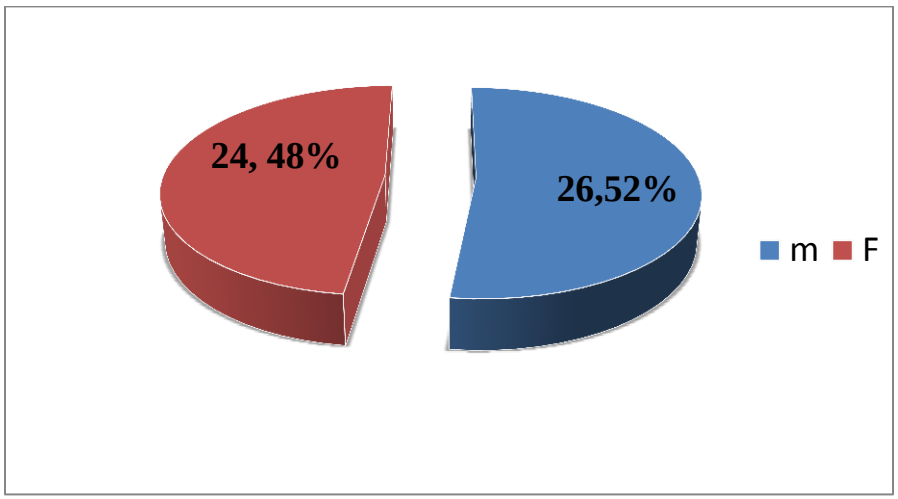


Fig (4 – 1) this pie graph represents the distribution of male and female frequency and percentage of diabetic patients

Table (4 – 2): show distribution of male and female frequency and percentage in control group.

	Frequency	Percentage
Male	45	45%
Female	55	55%
Total	100	100%

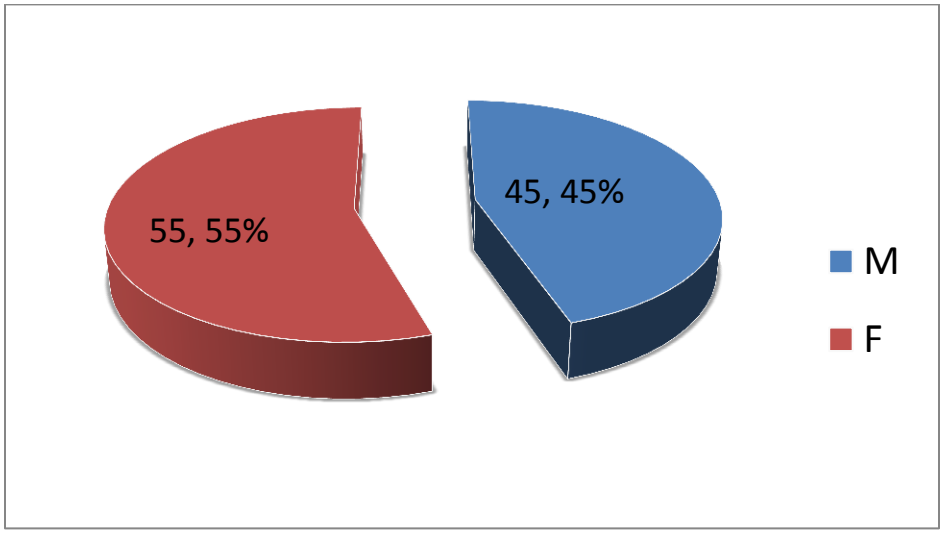


Fig (4 – 2) this pie graph represents the distribution of male and female frequency and percentage in control group.

Table (4 – 3): show distribution of classification of diabetic.

	Frequency	Percentage
Male	26	52%
Female	24	48%
Total	50	100%

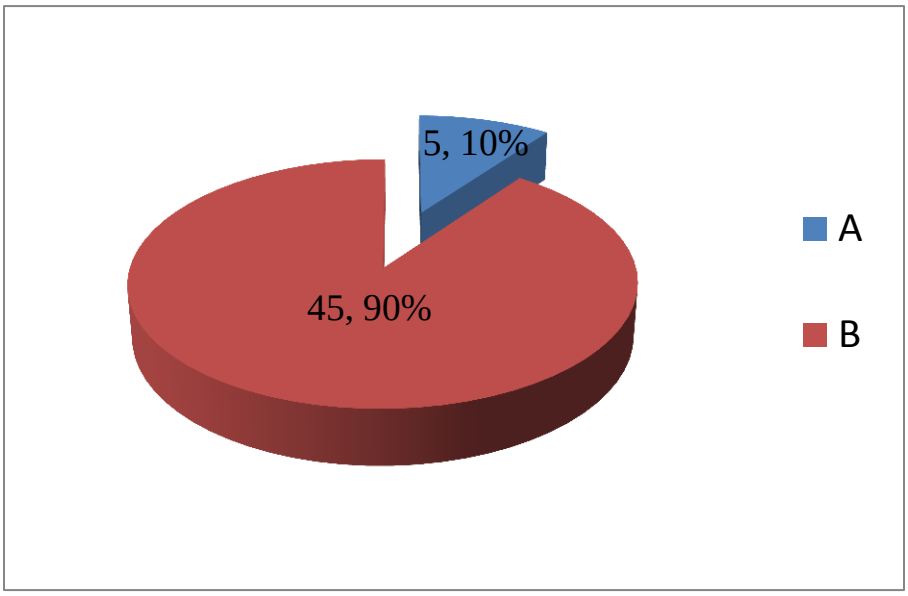


Fig (4 – 3) this pie graph represents the classification of diabetic

Table (4-4): patient's age, minimum, maximum, mean, and standard deviation data value of the diabetic patients measurement of right & left optic nerve.

	N	RT/ LT	Minimum	Maximum	Mean	Std. Deviation
OND	50	RT	2.02	3.42	2.49	0.27
		LT	2.00	3.00	2.47	0.24
ONSD	50	RT	4.00	6.12	5.03	0.53
		LT	4.15	6.02	5.08	0.48
Ocular	50	RT	1.00	1.50	1.12	0.15
		LT	1.00	1.63	1.1	0.20
Orbital	50	RT	25.00	30.13	26.14	1.17
		LT	25.00	30.35	26.1	1.1
Canalicular	50	RT	6.13	10.31	8.75	1.08
		LT	6.15	10.44	8.8	1.08
Cranial	50	RT	9.00	12.43	10.64	0.73
		LT	9.00	12.4	10.6	0.70
ON Length	50	RT	41.83	52.79	46.65	1.82
		LT	41.89	50.96	46.58	1.83

OND = Optic Nerve Diameter

ONSD = Optic Nerve Sheath Diameter

ON length = Optic Nerve Length

Table (4-5): patient's age, minimum, maximum, mean, and standard deviation data value of the control group measurement of right & left optic nerve.

	N	RT/ LT	Minimum	Maximum	Mean	Std. Deviation
OND	100	RT	2.78	4.00	3.06	0.23
		LT	2.75	4.00	3.05	0.23
ONSD	100	RT	4.10	6.00	5.05	0.35
		LT	4.00	6.00	5.06	0.35
Ocular	100	RT	1.00	1.50	1.10	0.13
		LT	1.00	1.50	1.10	0.13
Orbital	100	RT	25.00	30.00	25.88	0.78
		LT	25.00	30.00	25.88	0.78
Canalicular	100	RT	6.00	10.98	9.26	1.07
		LT	6.00	10.90	9.23	1.07
Cranial	100	RT	9.23	13.25	10.61	0.79
		LT	9.22	13.20	10.60	0.79
ON Length	100	RT	43.40	50.09	46.82	1.46
		LT	43.39	50.00	46.82	1.46

OND = Optic Nerve Diameter

ONSD = Optic Nerve Sheath Diameter

ON length = Optic Nerve Length

Independent Sample Test:

T- Test for Equality

Table (4 – 6) shows number, mean, stander deviation, T, and P- value of right and left measurement OND, ONSD and ON length in diabetic & control group.

ONSD\ Measurements	ON RT/ LT	Diabetic \ Control	N	Mean	Std. Deviation	T	P_ value
ONSD 3mm	RT	Diabetic	50	5.0324	.53498	-.260	.795
		control	100	5.0513	.34870	-.227	.821
	LT	Diabetic	50	5.0840	.48227	.330	.742
		control	100	5.0611	.35382	.298	.766
OND 3mm	RT	Diabetic	50	2.4932	.27391	-13.189	.000
		control	100	3.0579	.23285	-12.494	.000
	LT	Diabetic	50	2.4668	.23908	-14.644	.000
		control	100	3.0546	.22802	-14.413	.000
ON length	RT	Diabetic	50	46.6452	1.82119	-.647	.518
		control	100	46.8236	1.46340	-.602	.549
	LT	Diabetic	50	46.5836	1.82840	-.871	.385
		control	100	46.8237	1.45970	-.809	.421

P value of <0.05

Table (4 – 7) shows number, mean, stander deviation, T, and P- value of right and left measurement OND, ONSD and ON length in diabetic group.

ONSD\ Measurements	ON RT/ LT	Diabetic	N	Mean	Std. Deviation	T	P_ value
ONSD 3mm	RT	Diabetic	50	5.0324	.53498	0.507	0.614
	LT	Diabetic	50	5.0840	.48227		
OND 3mm	RT	Diabetic	50	2.4932	.27391	-0.513	0.609
	LT	Diabetic	50	2.4668	.23908		
ON length	RT	Diabetic	50	46.6452	1.82119	.169	.866
	LT	Diabetic	50	46.5836	1.82840		

Table (4 – 8) shows number, mean, stander deviation, T, and P- value of right and left measurement OND, ONSD and ON length in control group.

ONSD\ Measurements	ON RT/LT	Control	N	Mean	Std. Deviation	T	P_ value
ONSD 3mm	RT	Control	100	5.0513	.34870	-.197	.844
	LT	Control	100	5.0611	.35382		
OND 3mm	RT	Control	100	3.0200	0.20945.	-0.226	0.822
	LT	Control	100	3.0108	0.19740		
ON length	RT	Control	100	46.8236	1.46340	.000	1.000
	LT	Control	100	46.8237	1.45970		

P value of <0.05

Table (4 – 9) shows correlation of gender, age, and duration of diabetic with right and left optic nerve sheath diameter, optic nerve diameter and optic nerve length using Correlation Coefficient and significance 2 tailed tests in diabetic group.

Diabetic	RT/ LT		Gender	Age	Duration of Diabetic
ONSD 3mm	RT	Correlation Coefficient	0.093	- 0.20	0.093
		Sig. (2-tailed)	.521	.157	.521
		N	50	50	50
	LT	Correlation Coefficient	.103	-.122	-.135
		Sig. (2-tailed)	.478	.399	.349
		N	50	50	50
OND 3mm	RT	Correlation Coefficient	0.238	-0.37	0.238
		Sig. (2-tailed)	.096	.009	.096
		N	50	50	50
	LT	Correlation Coefficient	.293	-.377	-.503
		Sig. (2-tailed)	.039	.007	.000
		N	50	50	50
ON length	RT	Correlation Coefficient	-0.160	-0.13	-0.160
		Sig. (2-tailed)	.269	.367	.269
		N	50	50	50
	LT	Correlation Coefficient	-.182	-.035	-.138
		Sig. (2-tailed)	.207	.810	.341
		N	50	50	50

Table (4 – 10) shows correlation of gender and age with right and left optic nerve sheath diameter, optic nerve diameter and optic nerve length using Correlation Coefficient and significance 2 tailed tests in control group.

Control	RT/ LT		Gender	Age
ONSD 3mm	RT	Correlation Coefficient	-0.23	.275
		Sig. (2-tailed)	.022	.006
		N	100	100
	LT	Correlation Coefficient	-.230	.244
		Sig. (2-tailed)	.022	0.01
		N	100	100
OND 3mm	RT	Correlation Coefficient	-0.238	.264
		Sig. (2-tailed)	.017	.008
		N	100	100
	LT	Correlation Coefficient	-.317	.292
		Sig. (2-tailed)	.001	0.00
		N	100	100
ON length	RT	Correlation Coefficient	-0.317	.413
		Sig. (2-tailed)	.001	.000
		N	100	100
	LT	Correlation Coefficient	-.224	.428
		Sig. (2-tailed)	.025	0.00
		N	100	100

Table (4 – 11) shows means male and female of right and left measurement ONSD, OND and ON length in control & diabetic group.

ONSD\ Measurements	Gender	RT/LT	Mean/ control	Mean/ diabetic
ONSD 3mm	M	RT	5.1482	4.9819
		LT	5.1518	5.0385
	F	RT	4.9720	5.0871
		LT	4.9869	5.1333
OND 3mm	M	RT	3.1182	2.4523
		LT	3.0071	2.3985
	F	RT	3.0085	2.5375
		LT	2.9998	2.5408
ON length	M	RT	47.3351	46.8612
		LT	47.3009	46.8531
	F	RT	46.4051	46.4112
		LT	46.4333	46.2917

Table (4 – 12) shows the age of diabetic patients versus right measurement of optic nerve sheath diameter

Independent = X			
Dependent = Y			
Y = 5.445 – 0.007X	R	R sq	sign
	-0.20	0.031	0.022

Y = stand for Measurement of right optic nerve sheath diameter

X = stand for Age of diabetic patient

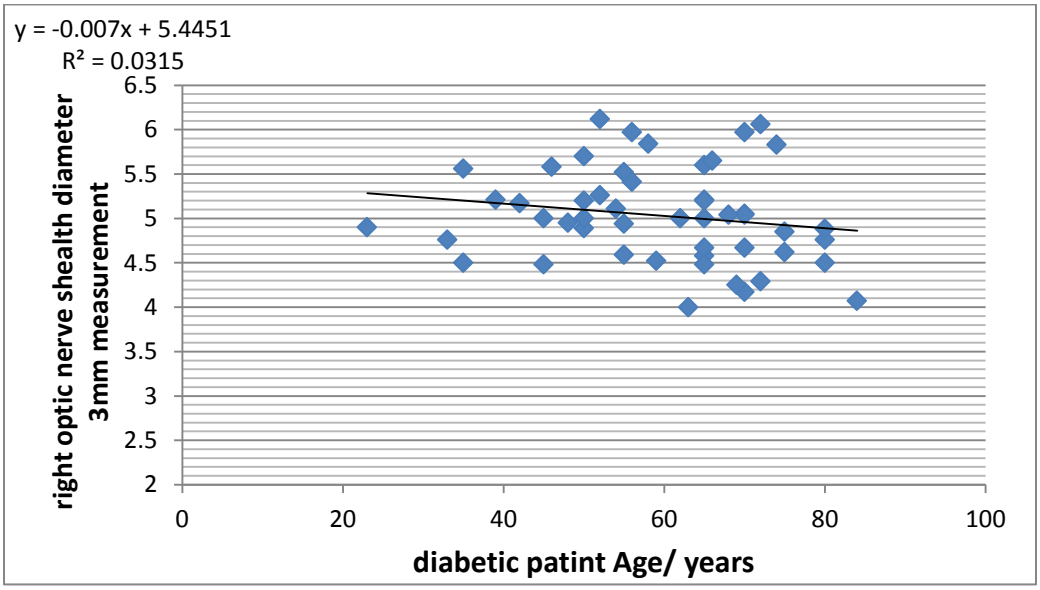


Fig.(4-4) scatter plot diagram shows the linear relationship between the age of diabetic patient and right optic nerve sheath measurement, when the age of diabetic patient increased the measurement decreased by -0.007 starting from 5.445 r2 = 0.031

Table (4 – 13) shows the age of diabetic patients versus left measurement of optic nerve sheath diameter

Independent = X			
Dependent = Y			
Y = 5.300 – 0.003X	R	R sq	sign
	-0.122	0.010	0.399

Y = stand for Measurement of left optic nerve sheath diameter

X = stand for Age of diabetic patient

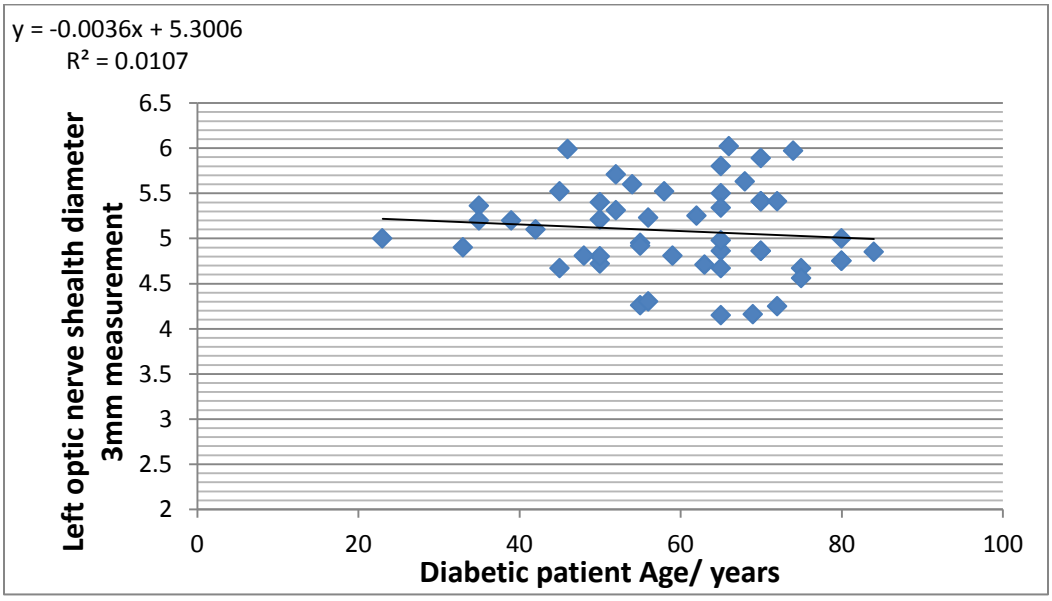


Fig.(4-5) scatter plot diagram shows the linear relationship between the age of diabetic patient and left optic nerve sheath measurement, when the age of diabetic patient increased the measurement decreased by -0.003 starting from 5.300 r2 = 0.010

Table (4 – 14) shows the age of diabetic patients versus right measurement of optic nerve diameter

Independent = X			
Dependent = Y			
Y = 2.835 – 0.005X	R	R sq	sign
	-0.37	0.082	.009

Y = stand for Measurement of right optic nerve diameter

X = stand for Age of diabetic patient

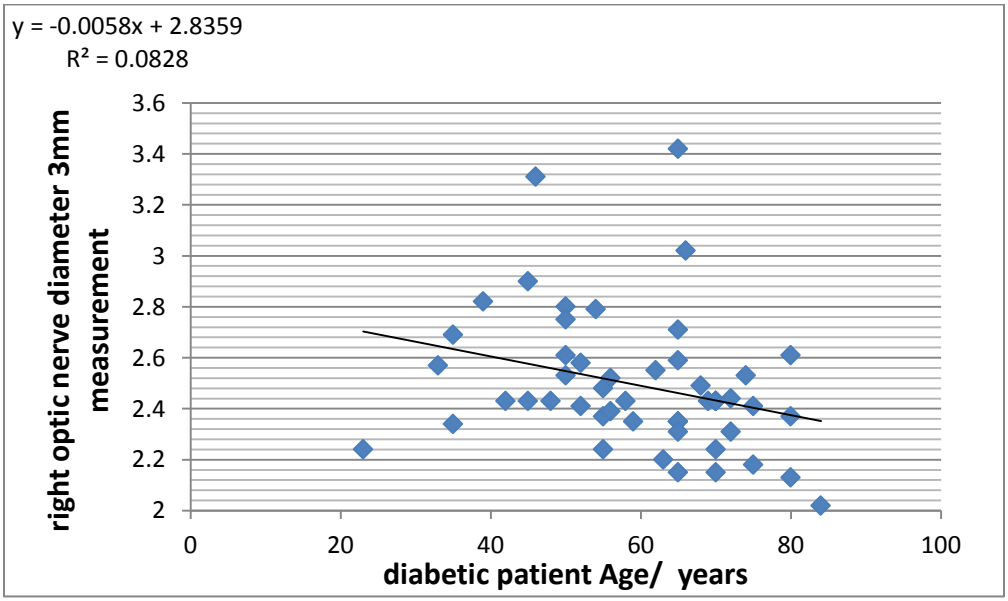


Fig.(4-6) scatter plot diagram shows the linear relationship between the age of diabetic patient and right optic nerve measurement, when the age of diabetic patient increased the measurement decreased by -0.005 starting from 2.835 r2 = 0.082

Table (4 – 15) shows the age of diabetic patients versus left measurement of optic nerve diameter

Independent = X			
Dependent = Y			
Y = 2.905 – 0.007X	R	R sq	sign
	-0.377	0.178	.007

Y = stand for Measurement of left optic nerve diameter

X = stand for Age of diabetic patient

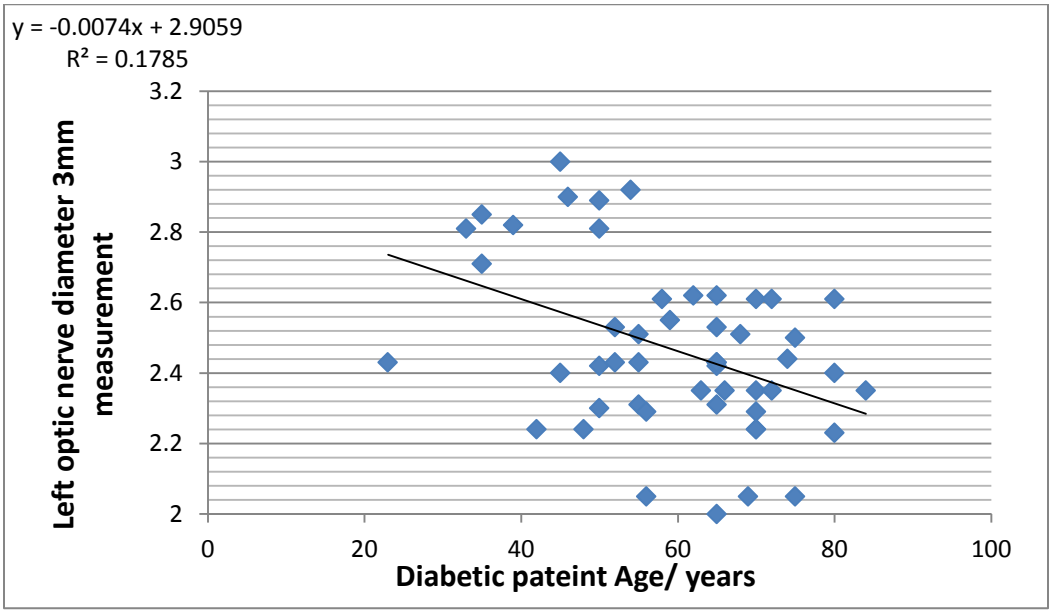


Fig.(4-7) scatter plot diagram shows the linear relationship between the age of diabetic patient and left optic nerve measurement, when the age of diabetic patient increased the measurement decreased by -0.007 starting from 2.905 r2 = 0.178

Table (4 – 16) shows the age of diabetic patients versus right measurement of optic nerve length

Independent = X			
Dependent = Y			
Y = 48.11 – 0.024X	R	R sq	sign
	-0.13	0.034	.367

Y = stand for Measurement of right optic nerve length

X = stand for Age of diabetic patient

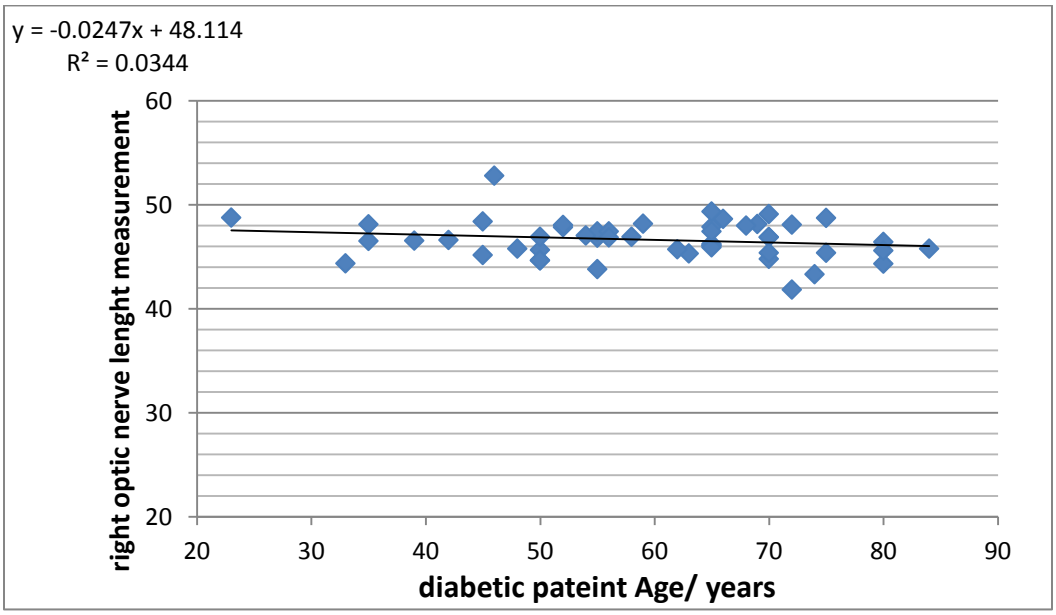


Fig.(4-8) scatter plot diagram shows the linear relationship between the age of diabetic patient and right optic nerve length measurement, when the age of diabetic patient increased the measurement decreased by -0.024 starting from 48.11 r2 = 0.034

Table (4 – 17) shows the age of diabetic patients versus left measurement of optic nerve length

Independent = X			
Dependent = Y			
Y = 46.93 – 0.005X	R	R sq	sign
	-0. 035	0.001	.810

Y = stand for Measurement of left optic nerve length

X = stand for Age of diabetic patient

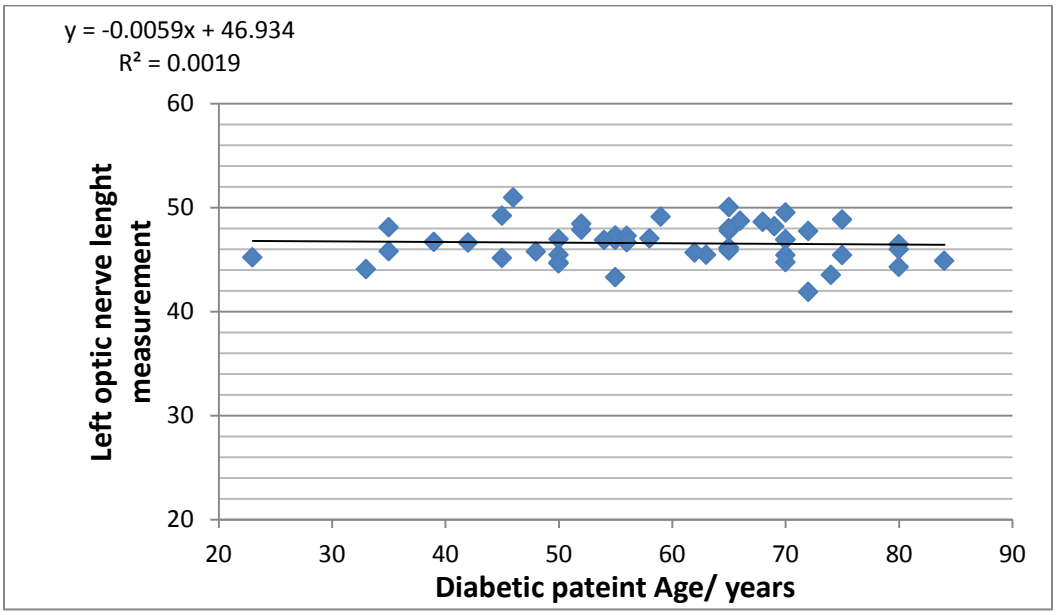


Fig.(4-9) scatter plot diagram shows the linear relationship between the age of diabetic patient and left optic nerve measurement, when the age of diabetic patient increased the measurement decreased by -0.005 starting from 46.93 r2 = 0.001

Table (4 – 18) shows the duration of diabetic versus right measurement of optic nerve sheath diameter

Independent = X			
Dependent = Y			
Y = 32.20 – 3.988X	R	R sq	sign
	0.093	0.055	0.521

Y = stand for Measurement of right optic nerve sheath diameter

X = stand for duration of diabetic

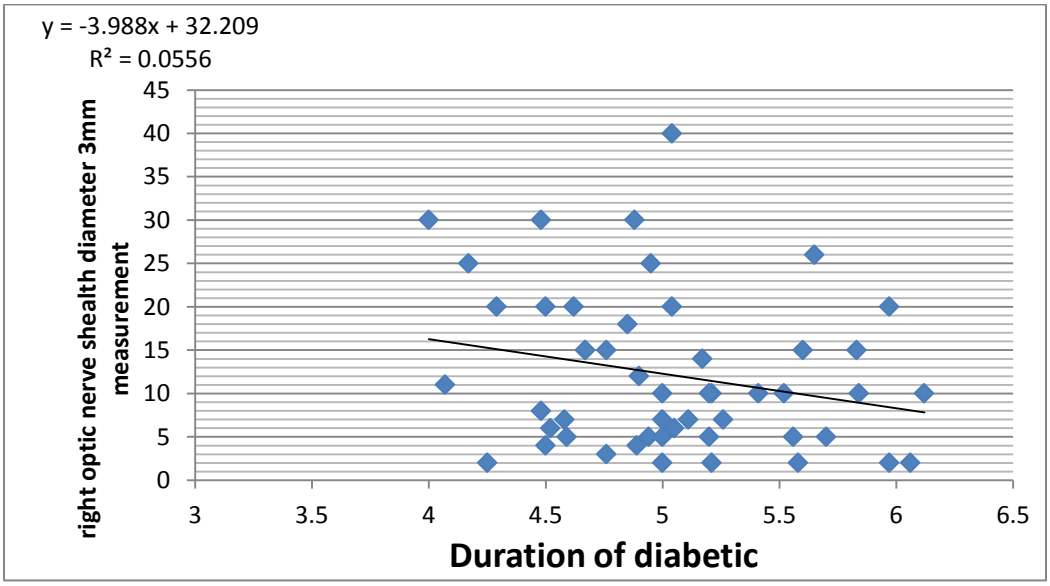


Fig.(4-10) scatter plot diagram shows the linear relationship between the duration of diabetic and right optic nerve sheath measurement, when the duration of diabetic increased the measurement decreased by -3.988 starting from 32.20 r2 = 0.055

Table (4 – 19) shows the duration of diabetic versus left measurement of optic nerve sheath diameter

Independent = X			
Dependent = Y			
Y = 17.46 – 1.046X	R	R sq	sign
	-.135	0.003	0.349

Y = stand for Measurement of left optic nerve sheath diameter

X = stand for duration of diabetic

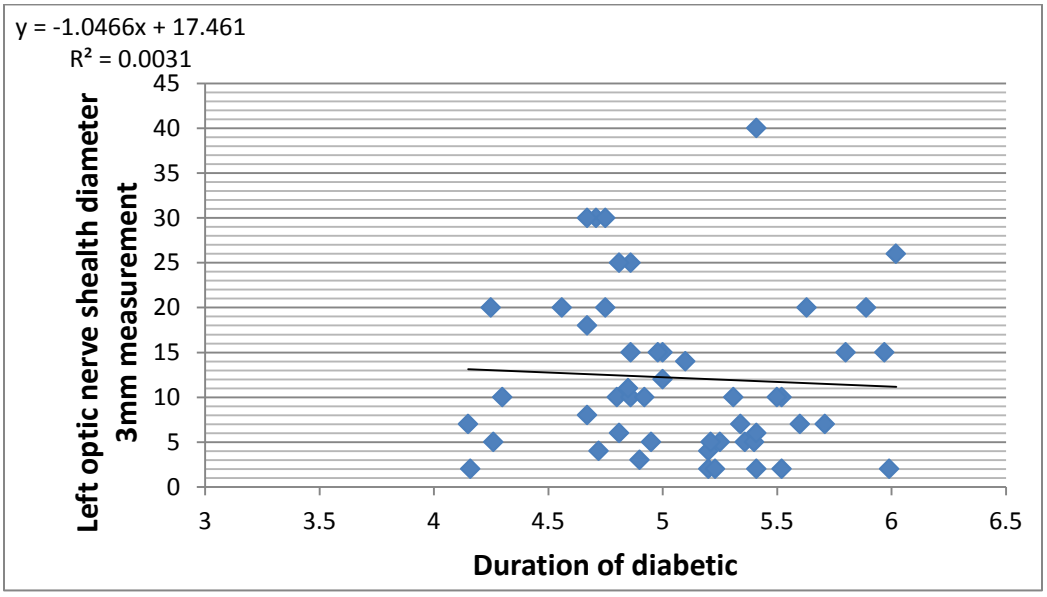


Fig.(4-11) scatter plot diagram shows the linear relationship between the duration of diabetic and left optic nerve sheath measurement, when the duration of diabetic increased the measurement decreased by -1.046 starting from 17.46 r2 = 0.003

Table (4 – 20) shows the duration of diabetic versus right measurement of optic nerve diameter

Independent = X			
Dependent = Y			
Y = 37.47 – 10.16X	R	R sq	sign
	0.238	0.094	.096

Y = stand for Measurement of right optic nerve diameter

X = stand for duration of diabetic

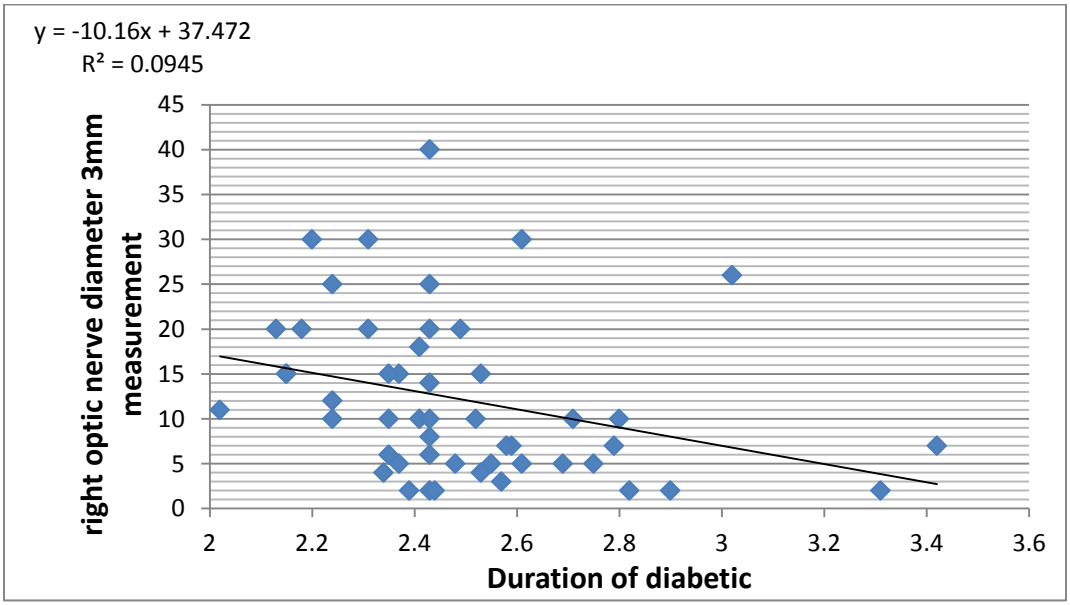


Fig.(4-12) scatter plot diagram shows the linear relationship between the duration of diabetic and right optic nerve measurement, when the duration of diabetic increased the measurement decreased by -10.16 starting from 37.47 r2 = 0.094

Table (4 – 21) shows the duration of diabetic versus right measurement of optic nerve diameter

Independent = X			
Dependent = Y			
Y = 53.24 – 16.66X	R	R sq	sign
	-0.503	0.193	.000

Y = stand for Measurement of left optic nerve diameter

X = stand for duration of diabetic

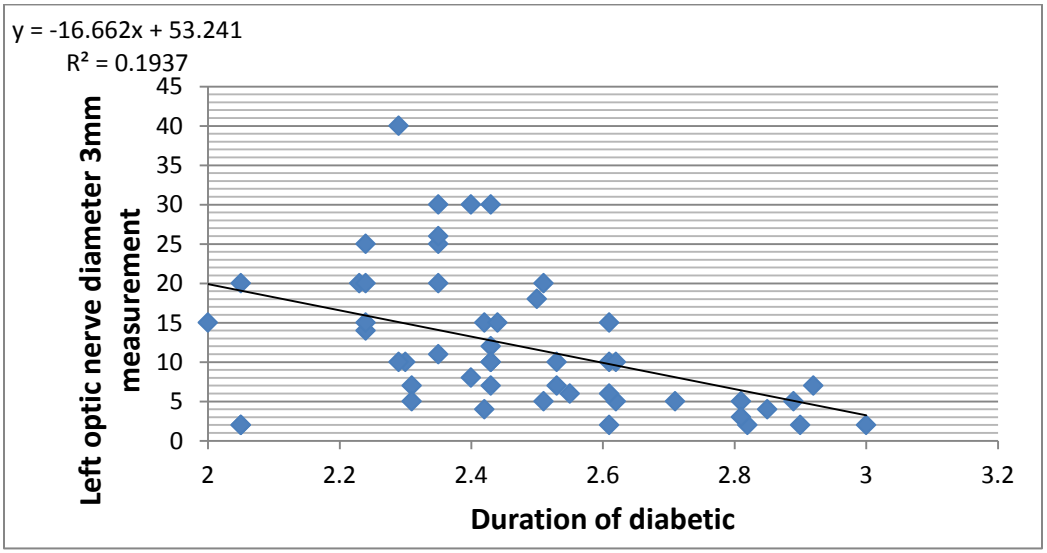


Fig.(4-13) scatter plot diagram shows the linear relationship between the duration of diabetic and left optic nerve measurement, when the duration of diabetic increased the measurement decreased by -16.66 starting from 53.24 r2 = 0.193.

Table (4 – 22) shows the duration of diabetic versus right measurement of optic nerve length

Independent = X			
Dependent = Y			
Y = 38.54 – 0.566X	R	R sq	sign
	-0.160	0.013	.269

Y = stand for Measurement of right optic nerve length

X = stand for duration of diabetic

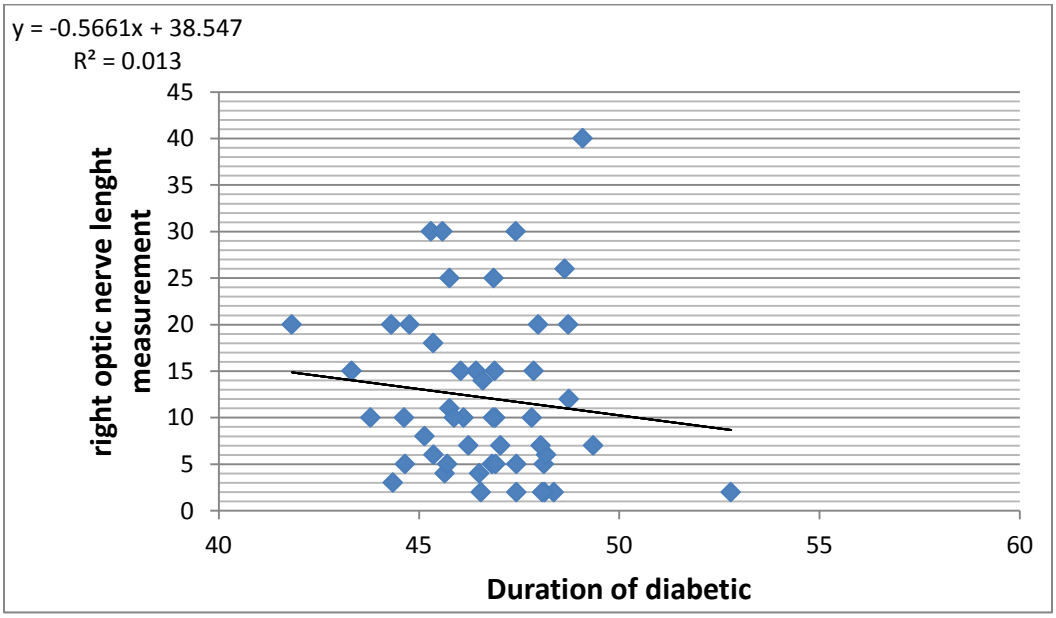


Fig.(4-14) scatter plot diagram shows the linear relationship between the duration of diabetic and right optic nerve measurement, when the duration of diabetic increased the measurement decreased by -0.566 starting from 38.54 r2 = 0.013.

Table (4 – 23) shows the duration of diabetic versus left measurement of optic nerve length

Independent = X			
Dependent = Y			
Y = 21.86 – 0.208X	R	R sq	sign
	-0.138	0.001	.341

Y = stand for Measurement of left optic nerve length

X = stand for duration of diabetic

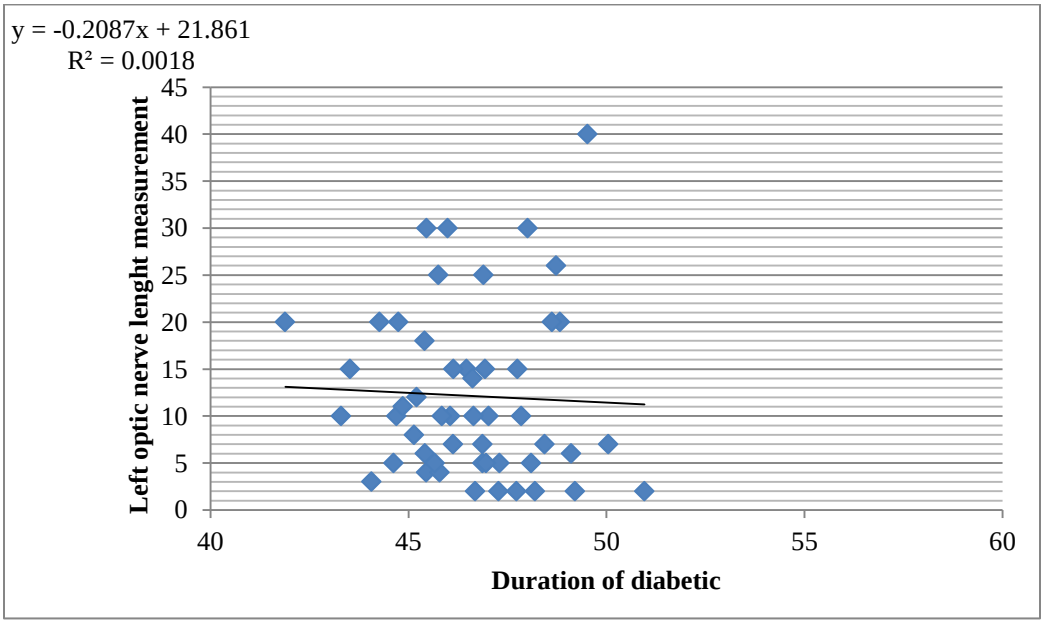


Fig. (4-15) scatter plot diagram shows the linear relationship between the duration of diabetic and left optic nerve measurement, when the duration of diabetic increased the measurement decreased by -0.208 starting from 21.86 r2 = 0.001.

Chapter Five

Discussion, Conclusion

&

Recommendations

Chapter Five

Discussion, Conclusions and Recommendations

5.1 Discussion:

This study aimed to assess the MRI indices for optic nerve in diabetic patients. By measuring the diameter and length of optic nerve and compared to control, statistical significance was demonstrated regarding. About fifty patient of diabetic exam were done, for right and left optic nerve, evenly with males about 52% and female were about 48% of total MRI exam table and Fig (4.1), in diabetic group with classification of diabetic in type 1 and type 2 by 10% , to 90%from total MRI exam table and Fig (4.3). And about 100 of control subject with 45% in male and 55% in female of total MRI exam table and Fig (4.2).

As showed in table 4-4, for diabetic patients mean of age was 59.4 ± 13.7 min 23, max 84years old, ONSD 5.1 ± 0.5, min 4.15 and max6.0, the mean of OND 2.5±0.2 with min 2.00 and max 3.00 in diameter measurement of optic nerve. And the total part of optic nerve were found the means ocular, orbital, canalicular and cranial were found 1.1± 0.2, 26.1± 1.1, 8.8 ± 1.1, and 10.6 ± 0.7. And the mean total length of optic nerve was found 46.6± 1.8.

The study indicates that optic nerves MRI parameter in patient at risk of diabetes are from reference values that have been reported from healthy subject. (Lagrèze; et al 2009), (Bergmann, et al 2016).

In table 4-5 showed the mean of age of control groups is 39.46± 15.81, the mean of measurement ONSD , OND were found 5.05± 0.35 min 4.1, max 6.00, 3.06 ± 0.23, min 2.87, and max 4.00 in diameter measurement of optic nerve near to J.D. Benevento, et al 2011 study of optic nerve measurements in normal human eyes and they used coronal MRI imaging of normal human eyes its showed an average ONSD range of 4.00 – 6.00mm ± 0.5mm, and an average OND range of 2.6 – 4.00mm ± 0.3 mm.

Measuring the ONSD is important because it covers an important anatomy which is the optic nerve, and changing of the ONSD can be as an indicator of some pathological changes (Hansen HC, 1996) (Helmke K, 1996)

Analyzing the main findings obtained; firstly we will discuss the fact of using the 3 mm distance from the globe as an ideal location to measure ONSD .Anatomically it was found that the sheath is normally found to be loose near the eyeball, with a much bigger space between the optic nerve and the sheath than anywhere else in its course, thus presenting bulbous form behind the eyeball (Hayreh SS, 1984). This fact is confirmed up-to-date (Lindner T, 2014).This was found to ease the movement of optic nerve's head while moving with the eye .Further histologic studies revealed a segment of the optic nerve in which maximal diameter

fluctuations could be expected, namely the bulging dura mater region around 3 mm behind the papilla (Geeraerts T,2007). This position was recommended for the ONSD measurements for monitoring many diseases and this was used in many studies (Kimberly HH, 2008) (Moretti R, 2009) We apply ONSD at that point for monitoring and evaluating the ON and ONS in both normal and diabetes groups, because studies have mentioned that, the enlargement of ONSD behind the globe at the position recommended for the ONSD measurements in cases of raised intracranial pressure was found also in papilledema, optic nerve lesions, optic atrophy, and endocrine orbitopathy. (Passi N,2013) (Frumin E, 2014)(Breuer T,2007) (Carlson AP, 2013).

The optic nerve was protected by the adipose body of the orbit(Cheng-Chun Chen1,2009), for this reason we used T2-weighted FSE sequences with fat-suppression because it have been found to be optimal for visualizing the ONS and perioptic CSF.(Degnan AJ, 2011& Kimberly HH, 2008 & Geeraerts T, 2008)

A good understanding of the structure of the ON and topographic localization of the nerve fibers in it from the various parts of the retina is essential for comprehension of various aspects of optic neuropathology. The importance in taking care about the ON is because the perioptic meninges or ONS envelope the length of the ON up to the globe and continued with the intracranial meninges. For this reason, pressure changes in the intracranial space can be transmitted to the optic papilla via the sub arachnoid space(SAS) accompanying the ONS.(Jinkins JR, 1996) as well the SAS of the ON divisions are not uniform in architecture: consists of trabeculae, septa and pillars, trabeculae and pillars. (Killer HE, 2003) This architectural meshwork may affect the pressure within the nerve. However we did not consider the sheath in our evaluation which may consider as limitation. The overall mean length of the right and left optic nerve for all the patients studied was 46.82mm ± 1.46 and 46.82 mm±1.46 respectively. The minimum was 43.40mm and maximum was 50.09mm in the right side and from 43.39mm to 50mm in maximum for the left, this was presented in table (M. C. Yiannakas, 2009 & Montaleone P, 2010).

And the total part of optic nerve were found the means ocular, orbital, canalicular and cranial were found 1.10± 0.13, 25.88± 0.78, 9.26 ± 1.07, and 10.61 ± 0.79. And the mean total length of optic nerve was found 46.82± 1.46. Near to Foram Gala, 2015 Magnetic resonance imaging of optic nerve, Normal anatomy. Axial T2 fat-saturated image shows the segmental anatomy of the optic nerve. Intraocular (1 mm) - when it emerges through the scleral opening, Intraorbital (25 mm) - the longest segment and communication between subarachnoid spaces around the optic nerve with that in suprasellar cistern, Intracanalicular (9 mm) - as it passes through bony optic canal along with ophthalmic artery (OA)and Prechiasmatic (16 mm) - intracranial segment in suprasellar cistern.

Axial T2 -weighted turbo spin-echo fat-suppressed sequence was used to measure ONSD, optic nerve diameter (OND) and optic nerve length. The scan parameters were as follows: repetition time 3500, echo time 86.6/Ef, slice thickness 3 mm, spacing between slices 0.0 mm, felid of view 16*16 and matrix is 320*224. The optic nerve sheath appeared as a high signal surrounding a region of low signal corresponding to the optic nerve. The axial image slice that provided the best view of the ONSD. The retrobulbar area was zoomed to 300×, and then ONSD and OND were measured in an axis perpendicular to the optic nerve, 3 mm behind the globe using an electronic caliper. The ONSD, OND and optic nerve length values obtained from both sides were averaged for comparison with standard range of optic nerve.

All measurements obtained from axial plane in 3mm behind the eyeball to ONSD, OND in diameter and about the length of optic nerve was measured at four step starting passes through sclera, choroid, and appears in eye as optic disc there are intraocular portion, intraorbital part; extends from back of the eyeball to the optic foramina, intracanalicular; as it passes through bony optic canal along with ophthalmic artery, and the area of the intracranial; lies above the cavernous sinus and converges with its fellow (over the diaphragma sellae) according to study of A.Prof Frank Gaillard, et al. Optic nerve the optic nerve is divided into four segments:

Intraocular segment: lies within the retina and emerges through a scleral opening (lamina cribrosa). intraorbital segment: passes posteriorly and centrally within the orbit and is surrounded by dural lining and CSF; hence it directly communicates with the subarachnoid space and therefore allows transmission of increased pressure from hydrocephalus to manifest as papilloedema; additionally the dural covering can develop a meningioma . intracanalicular segment: where the optic nerve exits through the tendinous ring and optic canal inferior to the ophthalmic artery .intracranial or cisternal segment: enters the middle cranial fossa and passes within the suprasellar cistern with the anterior cerebral artery at its superolateral aspect to join the contralateral optic nerve at the optic chiasm.

The current study used the axial MR T_2 weighted images to evaluate the ON length; axial sections were used because they are highly reproducible and are acquired according to a well-defined view. In addition, axial images are routinely used in our department as basic examination and are most likely to be available for the reviewing radiologist; this was also applied in another similar study (B. Shofty, 2012). Coronal images were not always obtained however coronal image acquisition is needed for optimal visualizing of the true dimensions of the on and perioptic CSF relative to the surrounding sheath.(Mashima Y,1996)

studies have mentioned that ON is about 50 mm in length (Montaleone P, 2010 & Lagre`ze WA, 2007) while another one stated that ON is about 35–55 mm from the

eyeball to the chiasma (Duke-Elder S, 1961) (Yiannakas, 2009), the optic nerve length obtained in this study was in the lower range of the values reported in previous studies.

In table (4.6) t – test for equality, p – value showed difference between the right and left optic nerve sample means in diabetic patient and control group, and stander deviation. A result, these data values can be used as same each one to other data value among this study was the total number of RT and LT optic nerve measurement. The result were found the p – value in the right and left ONSD, it's greater than 0.05 that lead to accept there is no deference between measurement diameter 3mm orbit in diabetic and control group.

The study indicated that MR OND measurement in diabetic patients differs from the reference values that have been read from normal in the control group. There is significant deference between measurement done for the right and left optic nerves between diabetic and control group. p=0.000

In ON length the P_value, it's greater than 0.05 that lead to accept there is no deference between measurements in right and left length optic nerve between diabetic, and control group.

From table (4.7) the results were found P – value of ONSD, OND and ON length between right and left diabetic, it's greater than 0.05 that lead to accept there is no deference between measurement of right and left.

From table (4.8) the results were found P – value of ONSD, OND and ON length between right and left control, it's greater than 0.05 that lead to accept there is no deference between measurement of right and left.

These results were used to find relationship between these optic nerve measurements in diameter and length to age, gender and diabetic duration in table (4.9) analysis using correlation coefficient and 2 – tailed significant was done and showed a relationship between right and left ONSD, OND and optic nerve length in diabetic group, the results was ONSD, RT – 0.20, LT – 0.12, OND, RT – 0.37, LT – 0.377, and optic length RT – 0.13 and LT – 0. 035, that when the age increased the optic nerve measurement well be decreased in diabetic patients group, and when the duration of diabetic increased the optic nerve measurement well be decreased aspect was reached in the previous studies done by (Alzain et al 2015), about measurement of the optic nerve in diabetic patient using magnetic resonance imaging MRI.

In table (4.10) showed relationship between these optic nerve measurements in diameter and length to age, and gender analysis using correlation coefficient and 2 – tailed significant was done and showed a relationship between right and left ONSD, OND and optic nerve length in control group, the results was ONSD, RT 0.275, LT 0.244, OND RT0.264, LT0.292 and ON length RT 0.413, and LT 0.428, that A positive linear relationship between the age with right and left optic nerve

length (r^2=0.159) and (r^2= 0.163) were noticed. The *p*- value of (t) test is (1.00) that led to accept that there is no deference between measurement length of the optic nerve for the right and left on length. Studies have mentioned that the length of the optic nerve varies widely, even between the two eyes of the same person (Duke-Elder S, 1961) (Yiannakas, 2009), this was not consistent with our study results.

In table (4 – 11) showed means of right and left measurement ONSD, OND and ON length in control & diabetic group according to gender male and female, the rustle were found The mean ONSD values in control for male were RT =5.1482, LT= 5.1518 and for female were RT= 4.9720, LT=4.9869 and OND for male were RT =3.1182, LT = 3.001, and for female were RT = 3.0085, LT = 2.9998 (Shirodkar, 2015, Correlation of measurement of optic nerve sheath diameter using ultrasound with magnetic resonance imaging).

A review of the literature has found the normal optic nerve sheath diameters just behind and 4 mm posterior to the globe are 5.52 ± 1.11 and 5.2 ± 0.9 mm. The optic nerve sheath is widest anteriorly behind the globe and narrowed toward the orbital apex. These dimensions are consistent with the results of a histologic study of the optic nerve. (Passi .N, et al studied MR Imaging of Papilledema and Visual Pathways: Effects of Increased Intracranial Pressure and Pathophysiologic Mechanisms, 2013).

From table(4.12) and figure (4.4) there is decreasing between age of diabetic patients as independent variable and relation measurement RT ONSD as dependent variable, with r – 0.20, and sign = 0.022. In Fig.2 scatter plot diagram shows the linear relationship between the age of diabetic patient and right optic nerve sheath measurement, when the age of diabetic patient increased the measurement decreased by -0.007 starting from 5.445 r2 = 0.031.

From table (4.13) and figure (4.5) there is decreasing between age of diabetic patients as independent variable and relation measurement LT ONSD as dependent variable, with r – 0.122, and sign 0.399. In Fig 2 scatter plot diagram shows the linear relationship between the age of diabetic patient and left optic nerve sheath measurement, when the age of diabetic patient increased the measurement decreased by -0.003 starting from 5.300 r2 = 0.010.

From table (4.14) and figure (4.6) there is decreasing between age of diabetic patient as independent variable and relation measurement RT OND as dependent variable, with r – 0.37 and sign, 0.009. In Fig scatter plot diagram shows the linear relationship between the age of diabetic patient and right optic nerve measurement, when the age of diabetic patient increased the measurement decreased by -0.005 starting from 2.835 r2 = 0.082.

From table (4.15) and figure (4.7) there is decreasing between age of diabetic patient as independent variable and relation measurement LT OND as dependent variable, with r – 0.38 and sign, 0.007. In Fig scatter plot diagram shows the linear

relationship between the age of diabetic patient and left optic nerve measurement, when the age of diabetic patient increased the measurement decreased by -0.007 starting from 2.905 r2 = 0.178.

From table (4.16) and figure (4.8) there is decreasing between age of diabetic patient as independent variable and relation measurement RT ON length as dependent variable, with r – 0.13 and sign, 0.37. In Fig scatter plot diagram shows the linear relationship between the age of diabetic patient and right optic nerve length measurement, when the age of diabetic patient increased the measurement decreased by -0.024 starting from 48.11 r2 = 0.034

From table (4.17) and figure (4.9) there is decreasing between age of diabetic patient as independent variable and relation measurement LT ON length as dependent variable, with r – 0.035 and sign, 0.81. In Fig scatter plot diagram shows the linear relationship between the age of diabetic patient and left optic nerve measurement, when the age of diabetic patient increased the measurement decreased by -0.005 starting from 46.93 r2 = 0.001.

The relationship of decreasing optic nerve measurement to age in diabetic patient can be aspect was reached in the previous studies done by (Alzain et al 2015), about measurement of the optic nerve in diabetic patient using magnetic resonance imaging MRI.

From table (4.18) and figure (4.10) there is decreasing between duration of diabetic as independent variable and relation measurement RT ONSD as dependent variable, with r 0.093 and sign, 0.521. In Fig scatter plot diagram shows the linear relationship between the duration of diabetic and right optic nerve sheath measurement, when the duration of diabetic increased the measurement decreased by -3.988 starting from 32.20 r2 = 0.055.

From table (4.19) and figure (4.11) there is decreasing between duration of diabetic as independent variable and relation measurement LT ONSD as dependent variable, with r – 0.135 and sign, 0.349. In Fig scatter plot diagram shows the linear relationship between the duration of diabetic and left optic nerve sheath measurement, when the duration of diabetic increased the measurement decreased by -1.046 starting from 17.46 r2 = 0.003.

From table (4.20) and figure (4.12) there is decreasing between duration of diabetic as independent variable and relation measurement RT OND as dependent variable, with r 0.238and sign, 0.096. In Fig scatter plot diagram shows the linear relationship between the duration of diabetic and right optic nerve measurement, when the duration of diabetic increased the measurement decreased by -10.16 starting from 37.47 r2 = 0.094.

From table (4.21) and figure (4.13) there is decreasing between duration of diabetic as independent variable and relation measurement LT OND as dependent variable, with r – 0.503 and sign, 0.000. In Fig scatter plot diagram shows the linear

relationship between the duration of diabetic and left optic nerve measurement, when the duration of diabetic increased the measurement decreased by -16.66 starting from 53.24 r2 = 0.193.

From table (4.22) and figure (4.14) there is decreasing between duration of diabetic as independent variable and relation measurement RT ON length as dependent variable, with r – 0.160 and sign, 0.269. In Fig scatter plot diagram shows the linear relationship between the duration of diabetic and right optic nerve measurement, when the duration of diabetic increased the measurement decreased by -0.566 starting from 38.54 r2 = 0.013.

From table (4.23) and figure (4.15) there is decreasing between duration of diabetic as independent variable and relation measurement LT ON length as dependent variable, with r – 0.138 and sign, 0. 341. In Fig scatter plot diagram shows the linear relationship between the duration of diabetic and left optic nerve measurement, when the duration of diabetic increased the measurement decreased by -0.208 starting from 21.86 r2 = 0.001.

The relationship of decreasing optic nerve measurement to duration of diabetic can be aspect was reached in the previous studies done by (Lagrèze et al, 2009, Retrobulbar Optic Nerve Diameter Measured by High-Speed Magnetic Resonance Imaging as a Biomarker for Axonal Loss in Glaucomatous Optic Atrophy) , (Bergmann et al, 2016, Optic Nerve Sheath Diameter Measurement During Diabetic Ketoacidosis: A Pilot Study).

High-resolution MRI is accurate at measuring ONSD and OND and has been proposed to detect decreasing in measurement. On T2-weighted sequences, water (and CSF) exhibits a high signal (white). Fat and grey matter appears as light grey and white matter as dark grey. The perioptic CSF is surrounded by orbital fat. Contrast between CSF and orbital fat can be improved with fat suppression, increasing the image resolution for the ONSD measurement.

Diabetic retinopathy is the most well-known ocular complication of diabetes and the leading cause of blindness among people 20–64 years of age in the U.S. Up to 4 million Americans with diabetes, 40 years of age and older, have retinopathy, and nearly 1 million have sight-threatening retinopathy. In major clinical trials, tight control of blood glucose and blood pressure has been demonstrated to reduce the risk of retinopathy and associated blindness.(Yanoff, 2009).

Often the early stages of diabetic retinopathy have no visual symptoms. That is why the American Optometric Association recommends that everyone with diabetes have a comprehensive dilated eye examination once a year. Early detection and treatment can limit the potential for significant vision loss from diabetic retinopathy

5.2 Conclusion:

The study indicates that optic nerve MRI measurement in diabetic patients at risk for diabetic are different from the reference values that have been reported from normal in the control group.

The P value (degree of significance between the control group and diabetic patient group) of the Age is 0.000.

The mean ONSD in the diabetic group was (5.03 ± 0.5mm; *P* =.795) ranging from 4.15 to 6.0mm. And was not significantly different from that in control group (5.05± 0.35mm; *P* = .821). ONSD did not differ between the diabetic patients and those with control group.

The mean OND in the diabetic group was (2.49 ± 0.2mm; *P* = 0.000) ranging from 2.00– 3.00mm. The mean OND in control group was significantly increase (3.06 ± 0.23 mm; *P* = 0.000). The OND was significantly decreased in diabetic patients with control group.

P = value is less than 0.05 that lead to accept there is a deference between measurement of optic nerve between diabetic and control group.

The mean ON length in the diabetic group was (46.6 ± 1.8mm; *P* =.385) ranging from 41.89to 51.0mm. And was not significantly different from that in control group (46.82± 1.46mm; *P* = .421). ON length did not differ between the diabetic patients and those with control group.

From the axial measurement of the optic nerve in diabetic patient group in the right and left optic nerve when the duration of diabetic increased the measurement decreased in the right optic nerve by -10.16 starting from 37.47 r2 = 0.094and left optic nerve by -0.007 starting from 2.905 r2 = 0.178 and that is **mean when the duration of diabetic increased the measurements of the optic nerve decreased.**

New equations were established for the prediction of the OND changes/reduction in known duration of diabetics =

Left (ON) diameter = - 16.07 X duration of diabetes/years +53.24

Right (ON) diameter = -10.16 X duration of diabetes /years +37.47

Frequently the early stages of diabetic retinopathy have no visual symptoms. That is why the American Optometric Association recommends that everyone with diabetes have to do eye examination once a year. Early detection can limit the potential for significant vision loss from diabetic.

A negative correlation between age to right and left ONSD and OND and ON length was found in the diabetic group. According to that was a positive correlation

between age to right and left ONSD, OND and ON length was found in the control group.

No statistical differences were found in the mean ONSD and OND width values between male and female in either the control group or the diabetic group.

MR imaging as measuring the ON, ONSD and ON length may facilitate for early prediction and detection of changes of elevated diabetic change in the optic nerve.

Globally, as of in 2015, an estimated 1.6 million deaths were directly caused by diabetes. Another 2.2 million deaths were attributable to high blood glucose in 2012.

Almost half of all deaths attributable to high blood glucose occur before the age of 70 years. WHO projects that diabetes will be seventh leading cause of death in 2030.

5.3 Recommendation:

Prevention is better than cures well all know it but I hope to apply it in our life by being a normal body weight, physical exercise, and following a healthy diet. Diet and physical training is the first line treatment. Regular blood sugar self controls should be used. If blood glucose is still not controlled, add treatment in next step.

Diabetic can also management concerned on keeping the blood sugar levels as closed to normal as possible by balancing food intake with medication and activity without causing hypoglycemia

Regular follows up is cornerstone in early detection and management of many eye complications due to diabetic.

Diabetic can be greatly reducing the possibilities of eye complication by scheduling the routine examination with an ophthalomolgist.

Learning people about the diabetic disease, complication of diabetic and treatment since the complications of diabetes are far less common and less severe in people who have well-managed blood sugar levels .

MRI is a more available tool in the orbital imaging techniques.

More precise measurements may be possible Using T2-weighted turbo spin-echo fat-suppressed sequence image MRI from larger sample size normal volunteers.

More measurements MRI images from larger sample size to diabetes patients

Further studies about the use of MRI compare to CT in assessment of optic nerve measurements is recommended.

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Appendices

PhD Diagnostic Radiologic Technology

Research About:

Characterization of the Optic Nerve Sudanese Patient Using MRI

(Control grope)

No	Age	Gender	Site	ONSD measurement	OND measurement	ON length measurement				ON length / total measurement
						Ocular	orbital	canal	cranial	

Signal Intensity / optic nerve	Signal Intensity / brain	Effect on retina	Other Finding					Final Diagnostic
			Globe	Lachrymal gland	Extra muscle	Intra fat	Orbital bone	

PhD Diagnostic Radiologic Technology

Research About:

Characterization of the Optic Nerve Sudanese Patient Using MRI

(Patients grope)

No	Age	Gender	Site	ONSD measurement	OND measurement	ON length measurement				ON length / total measurement
						Ocular	orbital	canal	cranial	

Signal Intensity / optic nerve	Signal Intensity / brain	Effect on retina	Type of diabetes	Duration of diabetes	Lab test	Other Finding					Final Diagnostic
						Globe	Lachrymal gland	Extra muscle	Intra fat	Orbital bone	