Sudan University of Sciences and Technology

College of Graduate Studies

Evaluation of Optic Nerve and Optic Chiasm using Magnetic Resonance in Diabetic Patients

تقييم العصب البصري والتصالب البصري باستخدام التصوير بالرنين المغناطيسي لمرضى السكري

A thesis Submitted for Partial Fulfillment for the Requirement of (M.Sc.) Degree in Medical Diagnostic Imaging

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الاية

﴿ألم تَرَ أنَّ الله أنزلَ من السَّماء ماءً فأخرجنا به ثمراتٍ مُخْتلفاً ألوانُها ومن الجبالِ جُدَدٌ بيضٌ وحمرٌ مختلفٌ ألوانُها وغرابيبُ سُودٌ ومن النَّاسِ والدَّوابِّ والأنعامِ مُختلفٌ ألوانُهُ كذلك إنَّما يَخشى الله من عبادهِ العلماءُ إنَّ الله عزيزٌ غفور﴾

(فاطر آية 27-28).

Dedication

I dedicated this work to:

My lovely father

My mother

My brother

And My friends

Acknowledgement

First of all, I am very grateful to God Almighty for enabling him to complete this message in due course and prayers and peace be upon the Compassionate Prophet Muhammad.

I am extremely grateful to many people who supported me during the preparation of this study. I would like to express deep gratitude to my supervisor **Dr. Babiker abd alwahab** for his support and guidance. And express my gratitude to all the relevant authorities that have allowed me to do so.

Abstract

This was across sectional descriptive study aimed to measure the damage of optic nerve and optic chiasm due diabetic in Sudanese people using magnetic resonance imaging. in addition to correlate the finding with age ,gender and duration of the diabetic .the study examined 50 subjects (30 diabetic patients and 20 normal)all of him done magnetic resonance for orbits)aged between 30-90years in both gender (15 diabetic male and 15 diabetic women,12 normal male and 8 normal female) were included in study. Data were collected at Khartoum state in Dar Alelaj hospital from September 2019 to February 2020.

study founded that the mean of optic nerve diameter in diabetic group was 2.68±0.34 mm for right side and 2.85±0.34 mm for left ,showed significant difference from that in control group 3.27±0.49 mm and 3.27±0.49 mm respectively .The study concluded that the measurement of optic nerve and optic chiasm is effect by diabetic, age and duration of diabetic but not effect by type of diabetic and gender. The study recommended that more precise measurement may be taken by using multi planer high resolution magnetic resonance image from larger sample size for normal volunteers.

المستخلص

دراسة وصفية مقطعية تهدف إلى قياس تلف العصب البصري والتصالب البصري الناجم عن مرض السكري لدى الشعب السوداني باستخدام التصوير بالرنين المغناطيسي. بالإضافة إلى ربط النتائج بالعمر والجنس ومدة مرض السكري ، فحصت الدراسة 50 شخصًا (30 مريض بالسكري و 20 شخصًا عاديًا) أجرى جميعهم رنين مغناطيسي للمدارات) تتراوح أعمارهم بين 30–90 عامًا في كلا الجنسين (15 ذكرًا و 15 امرأة مصابين بالسكري ، 12 ذكور و 8 إناث غير مصابين بالسكري) تم تضمينهم في الدراسة. تم جمع البيانات بولاية الخرطوم بمستشفى دار العلاج من سبتمبر 2019 إلى فبراير 2020. توصلت الدراسة إلى أن متوسط قطر العصب البصري في المجموعة المصابة بداء السكري كان 2.68 ± 0.34 للجانب الأيمن و 2.85 ± 0.34 لليسار ، وأظهرت فرقا معنويا عن ذلك في المجموعة الضابطة 3.27 ± 0.49 و 3.27 ± 0.49 على التوالي. العصب البصري والتصالب البصري يتأثران بمرض السكري وعمر ومدة مرض السكري ولكن لا يتأثران حسب نوع السكري والجنس. أوصت الدراسة بأخذ المزيد من قياس السمكة باستخدام صورة رنين مغناطيسي عالية الدقة متعددة المسوي من حجم عينة أكبر للحالة الطبيعية المتطوعين .

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Chapter One

Introduction

Chapter one

1-1: Introduction

The optic chiasm is an X-shaped space, located in the forebrain, directly in front of the hypothalamus. It is Crucial to vision; the left and right optic nerve intersect at the chiasm, thus creating the hallmark X-shape. One half of each nerve's axons thread like enter the opposite tract at this location, making it a partial decussation **(**crossing). The optic nerve is the sensory nerve of the retina. Its fibers originate in the ganglion layer and converge on the posterior part of the eye ball. The nerve passes backwards through the orbit and optic canal into the middle cranial fossa where it unites with the nerve of opposite side of the optic chiasm. Diabetes is a common cause of damage to the optic nerve and optic chiasm. It is a condition where the body's incapable of correctly processing and using sugar. The body's incapable of metabolizing sugars properly, resulting in high levels of glucose within the blood. When left untreated for prolonged periods, blindness can result from damage to the optic nerve and chiasm. Blurred vision usually occurs prior to complete vision loss in diabetic patients. MRI has a great value in measurements of the optic nerve and optic chiasm in diabetic patients.[welsey,2003]

1-2 : problem of the study:

Diabetic can affect human being health which usually affect optic nerve disorder therefore MRI has great value in measurement to see the extent of the damage caused by diabetes .

1-3: General Objective:

Measuring the effectiveness of magnetic resonance imaging to measure the damage of the optic chiasm and the optic nerve due to diabetes.

1-4 : Specific Objectives:

To measure the optic nerve and optic chiasm diameters in coronal and sagittal MRI images.

To compare the findings with control group.

To correlate the findings with patient age, gender and duration of diabetes.

To correlate the findings with diabetes type.

1.5 The overview of the study:

Chapter one deals with introduction, problem, objectives, significance and overview of research. Chapter two deals with literature review including theoretical background (anatomy, physiology and pathology) and previous studies. Chapter three deals with research Materials and Methods Chapter four deals with results and finally chapter five deals with discussion, conclusion and recommendation.

Chapter Two

Literature Review

2-1 : Anatomy of the Eye:

There are Three layers of tissue from the eye ball: the sclera, the choroids and the retina. The outer layer of sclera consists of though fibrous tissue. The white of the eye is part of the front surface of the sclera. The other part of the front surface of the sclera is called the cornea and is sometimes described as the window of the eye because of its transparency. At casual glance however it does not look transparent but appears blue, brown, gray or green because it lies over the iris, the colored part of the eye. A mucous membrane known as the conjunctiva lines the eyelids and covers the sclera in front. The conjunctiva is kept moist by tears formed in the lacrimal gland located in the upper lateral portion of the orbit. The middle layer of the eyeball, the choroid, contains a dark pigment to prevent the scattering of incoming light rays. Two involuntary muscles make up the front part of the choroids. One is the iris, the colored structure seen through the cornea and the other is the ciliary muscle.The black center of the iris is really a hole in this doughnut-shape muscle it is pupil of the eye. Some of the fibers of the iris are arranged like spokes in a wheel. When they contract the pupils dilate, letting in more light rays. Other fibers are circular. When they contract, the pupils Constrict letting fewer light rays. Normally the pupils constrict in bright light and dilate in dim light. When we look at distant objects, the ciliary muscle is relaxed and the lens has only a slightly curved shape to focus on near objects however, the ciliary muscle contract. As it contracts, it pulls the choroids coat forward toward the lens, thus causing the lens to bulge and curve even more. Most of us become more farsighted as we grow older and lose the ability to focus on close objects because our lenses lose their elasticity and con no longer bulge enough to bring near objects into focus. Presbyopia or old sightedness is the name for this condition. The retina or innermost layer of the eyeball contains microscopic receptor cells, called rods and

cones because of their shapes. Dim light can stimulate the rods, but fairly bright light is necessary to stimulate the cones. In other words, rods are the receptors for night vision and cones for day time vision. There are three kinds of cones; each is sensitive to a different color: red, green, or blue. Scattered throughout the central portion of the retina, these three types of cones allow us to distinguish between different colors. (Welsey, 2003)

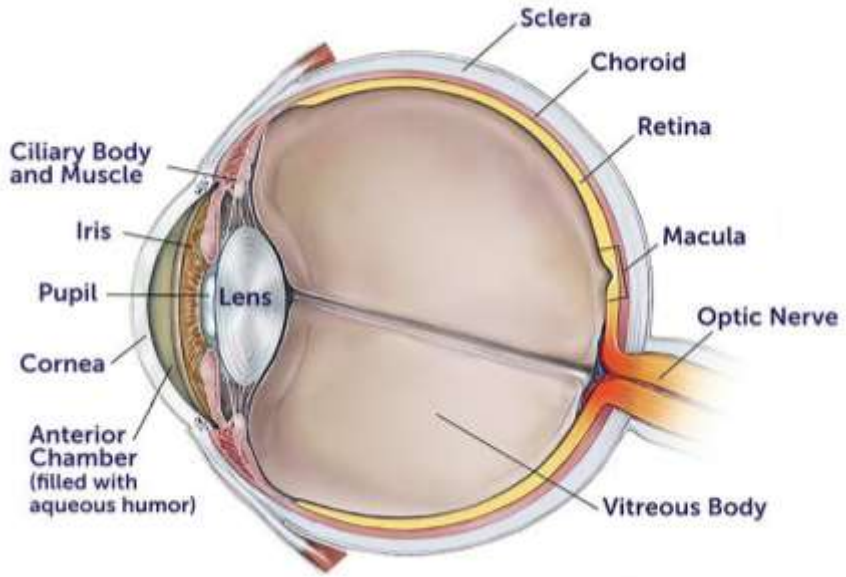

Figure no (2-1) shows anatomy of the eye (Welsey, 2003)

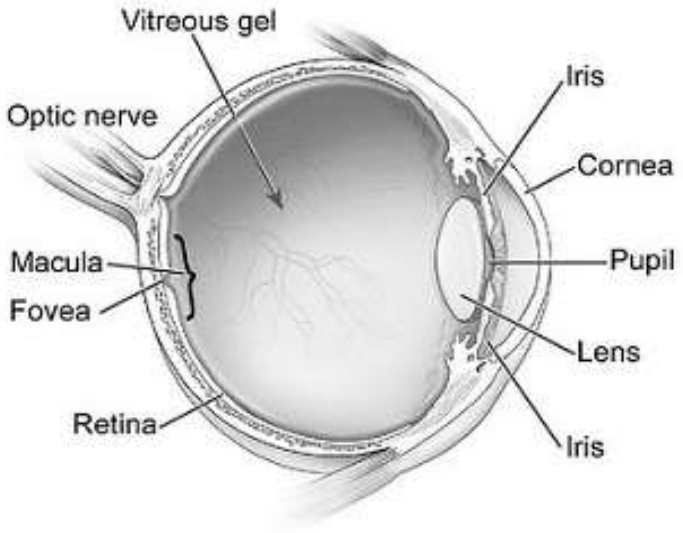

Figure no (2-2) show inner structure eye (Welsey, 2003)

2-1-1 : The Optic Nerve:

The optic nerve is located in the back of the eye. It is also called the second cranial nerve or cranial nerve II**.** It is the second of several pairs of cranial nerves. The job 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. Our blind spot is caused by the absence of specialized photosensitive (light-sensitive) cells, or photoreceptors, in the part of the retina where the optic nerve exits the eye. (S. J. et al, 2009)

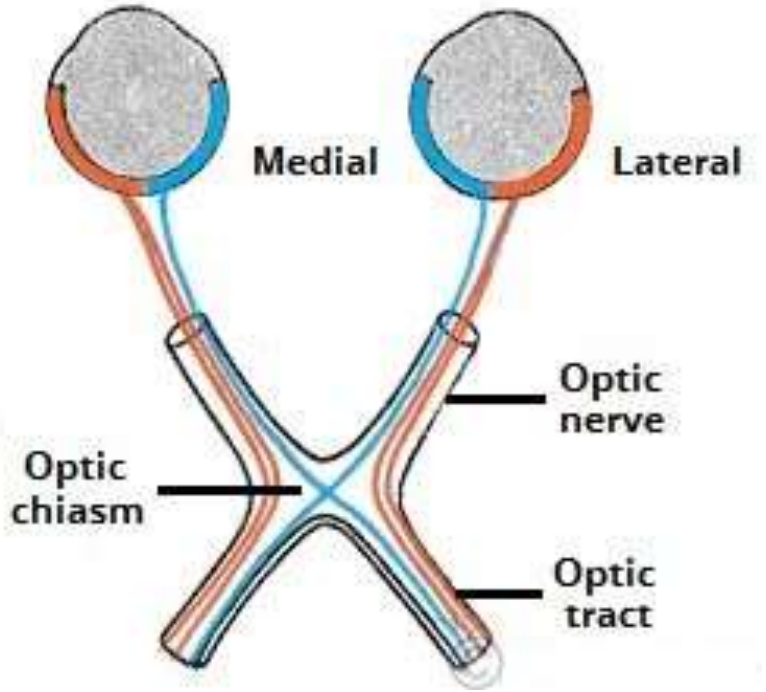

Figure no (2-3) shows the optic nerve and optic chiasm (S. J. et al, 2009)

2-1-2 : Visual pathway:

he axons of the ganglion cells converge on the region of the retina called the papilla or optic disk. They leave the globe as the optic nerve, in which they maintain an orderly arrangement in the sense that fibers from the macular zone of the retina occupy the central portion, the fibers from the temporal half of the retina take up a concentric position, and so on; when outside the

orbit, there is a partial decussation (crossover). The fibers from the nasal halves of each retina cross to the opposite side of the brain, while those from the temporal halves remain uncrossed. This partial decussation is called the chiasm. The optic nerves after this point are called the optic tracts, containing nerve fibers from both retinas. The result of the partial decussation is that an object in, say, the right-hand visual field produces effects in the two eyes that are transmitted to the left-hand side of the brain only. With cutaneous (skin) sensation there is a complete crossing-over of the sensory pathway; thus, information from the right half of the body, and the right visual field, is all conveyed to the left-hand part of the brain by the time that it has reached the diencephalon (the posterior part of the forebrain). (S. J. et al, 2009)

2-1-3 : Blind spot:

The beginning of the optic nerve in the retina is called the optic nerve head or optic disc. Since there are no photoreceptors (cones and rods) in the optic nerve head, this area of the retina cannot respond to light stimulation. As a result, it is known as the "blind spot," and everybody has one in each eye. 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. (S. J. et al, 2009)

2-1-4 : The Retina:

The retina is a complex transparent tissue consisting of several layers, only one of which contains light-sensitive photoreceptor cells. Light must pass through the overlying layers to reach the photoreceptor cells, which are of two types, rods and cones, that are differentiated structurally by their distinctive shapes and functionally by their sensitivity to different kinds of light. Rods predominate in nocturnal animals and are most sensitive to

reduced light intensities; in humans they provide night vision and aid in visual orientation. Cones are more prominent in humans and those animals that are active during the day and provide detailed vision (as for reading) and color perception. In general, the more cones per unit area of retina, the finer the detail that can be discriminated by that area. Rods are fairly well distributed over the entire retina, but cones tend to concentrate at two sites: the fovea centralis, a pit at the rear of the retina, which contains no rods and has the densest concentration of cones in the eye, and the surrounding macula lutea, a circular patch of yellow-pigmented tissue about 5 to 6 mm (0.2 to 0.24 inch) in diameter.

When light enters the eye, it passes through the cornea and the lens and is refracted, focusing an image onto the retina. Light-sensitive molecules in the rods and cones react to specific wavelengths of light and trigger nerve impulses. Complex interconnections (synapses) between and within retinal cell layers assemble these impulses into a coherent pattern, which in turn is carried through the optic nerve to the visual centers of the brain, where they are further organized and interpreted. (Ted, 1998)

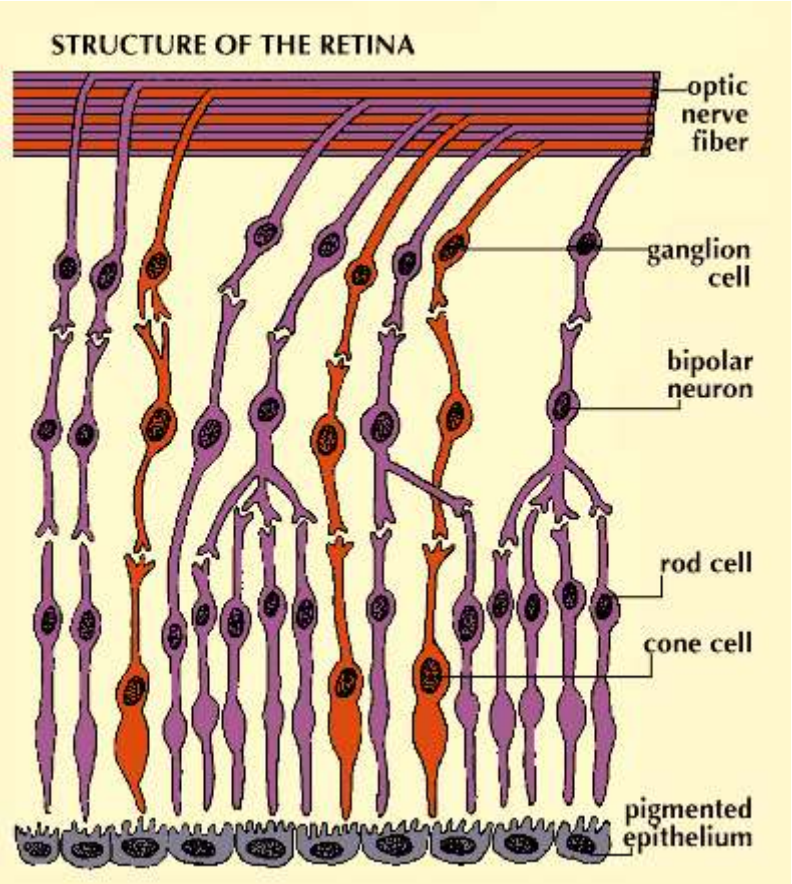

Figure no (2-4) shows the retina (Ted, 1998)

2-2 Physiology of the Eye:

2-2-1: Process of vision:

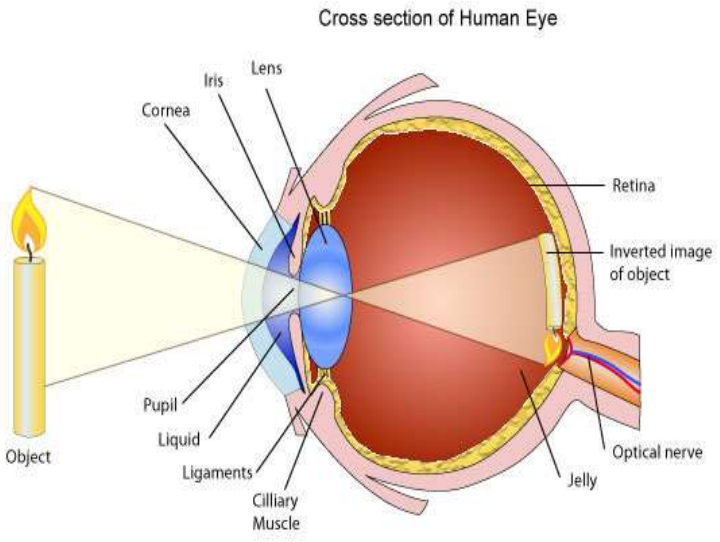

Figure no (2-5) show the process of vision (Ted, 1998)

light waves from an object (such as a tree) enter the eye first through the cornea, which is the clear dome at the front of the eye. It is like a window that allows light to enter the eye. The light then progresses through the pupil, the circular opening in the center of the colored iris. Fluctuations in the intensity of incoming light change the size of the eye's pupil.As the light entering the eye becomes brighter, the pupil will constrict (get smaller), due to the pupillary light response As the entering light becomes dimmer, the pupil will dilate (get larger).Initially, the light waves are bent or converged first by the cornea, and then further by the crystalline lens (located immediately behind the iris and the pupil), to a nodal point (N) located immediately behind the back surface of the lens.At that point, the image becomes reversed (turned backwards) and inverted (turned upside-down) (Ted, 1998)

The light continues through the vitreous humor, the clear gel that makes up about 80% of the eye's volume and then, ideally, back to a clear focus on the retina, behind the vitreous. The small central area of the retina is the macula, which provides the best vision of any location in the retina. If the eye is considered to be a type of camera (albeit, an extremely complex one), the retina is equivalent to the film inside of the camera, registering the tiny photons of light interacting with it. Within the layers of the retina, light impulses are changed into electrical signals. Then they are sent through the optic nerve, along the visual pathway, to the occipital cortex at the posterior (back) of the brain. Here, the electrical signals are interpreted or "seen" by the brain as a visual image. (Ted, 1998)

2-3 : Pathology:

2-3-1 : Diabetes mellitus:

a disease in which the body’s ability to produce or respond to the hormone insulin is impaired, resulting in abnormal metabolism of carbohydrates and elevated levels of glucose in the blood and urine. (S. J. et al, 2009)

There are two main types of diabetes mellitus:

2-3-1-1 : Type 1 diabetes

Type1diabetes is an autoimmune condition. It is used to be called insulin-dependent diabetes and is caused by the body attacking its own pancreas with antibodies. In people with type 1 diabetes, the damaged pancreas doesn't make insulin. This type of diabetes may be caused by a genetic predisposition. It could also be the result of faulty beta cells in the pancreas that normally produce insulin. (S. J. et al, 2009)

2-3-1-2 : Type 2 diabetes

Type 2 diabetes occurs when the body doesn't produce enough insulin to function properly, or the body's cells don't react to insulin. This means glucose stays in the blood and isn't used as fuel for energy. Type 2 diabetes is often associated with obesity and tends to be diagnosed in older people. It's far more common than type 1 diabetes. (S. J. et al, 2009)

2-3-2 : The Causes :

The Causes Feature Comparison of type 1and 2 diabetes

Table no (2-1) shows comparison between diabetes types (S. J. et al, 2009):

Comparison of type 1 and 2 diabetes		
Feature	**Type 1 diabetes**	**Type 2 diabetes**
Onset	Sudden	Gradual
Age at onset	Mostly in children	Mostly in adults
Body size	Thin or normal	Often obese
Ketoacidosis	Common	Rare
Autoantibodies	Usually present	Absent
Endogenous insulin	Low or absent	Normal, decreased or increased
Concordance in identical twins	**50** %	**90** %
Prevalence	~**10** %	~**90** %

2-3-3 : Signs and symptoms:

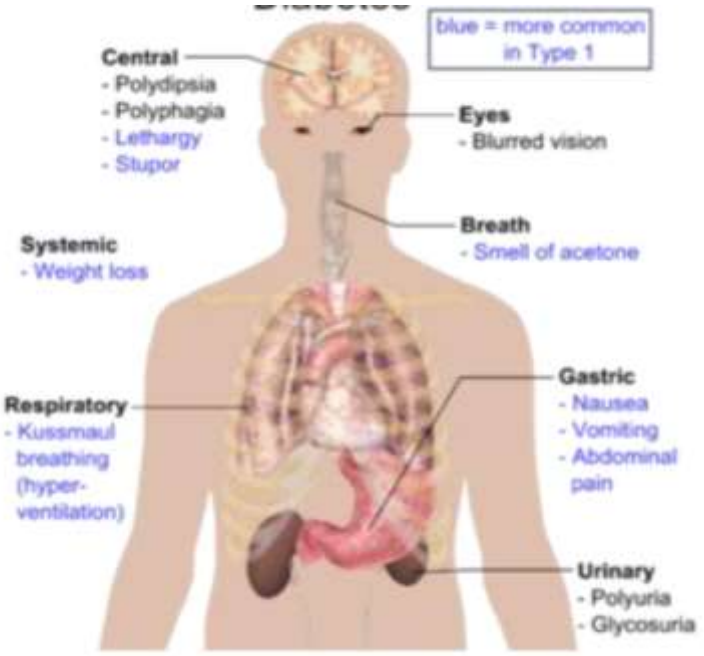

Figure no (2-6) show signs and symptoms of diabetes (S. J. et al, 2009)

Type 1: Increased urinary frequency (polyuria), thirst (polydipsia), hunger (polyphagia) and unexplained weight loss. Numbness in extremities, pain in feet (disesthesias), fatigue and blurred vision. Recurrent or severe infections. Loss of consciousness or severe nausea/vomiting (ketoacidosis) or coma. Ketoacidosis more common in T1D than in T2D. (S. J. et al, 2009)

Type 2: Patients may have no symptoms at all or minimal symptoms for years before being diagnosed. May have increased urinary frequency (polyuria), thirst (polydipsia), hunger (polyphagia) and unexplained weight loss. May also experience numbness in extremities, pain in feet (disesthesias) and blurred vision. May have recurrent or severe infections. patients may present with loss of consciousness or coma but this is less common than in T1D. (S. J. et al, 2009)

2-3-4 : Complications of diabetes mellitus

In patients with diabetes mellitus ,years of poorly controlled hyperglycemia lead to multiple, primarily vascular, complications that affect small vessels (microvascular), large vessels (macrovascular), or both .The mechanisms by which vascular disease develops include Glycosylation of serum and tissue proteins with formation of advanced glycation end products. Superoxide production. Activation of protein kinase C, a signaling molecule that increases vascular permeability and causes endothelial dysfunction. Accelerated hexosamine biosynthetic and polyol pathways leading to sorbitol accumulation within tissues. Hypertension and dyslipidemias that commonly accompany diabetes mellitus. Arterial microthromboses. Proinflammatory and prothrombotic effects of hyperglycemia and hyperinsulinemia that impair vascular autoregulation. Immune dysfunction is another major complication and develops from the direct effects of hyperglycemia on cellular immunity. (S. J. et al, 2009)

2-3-5 : The effect of diabetes on eyes:

Diabetic eye disease is a group of eye conditions that can affect people with diabetes.

Diabetic retinopathy affects blood vessels in the light-sensitive tissue called the retina that lines the back of the eye. It is the most common cause of vision loss among people with diabetes and the leading cause of vision impairment and blindness among working-age adults.

Diabetic macular edema (DME). A consequence of diabetic retinopathy, DME is swelling in an area of the retina called the macula. (J.D., 2011)

2-3-6 : The effect of diabetes on optic nerve :

Diabetic Papillopathy : Diabetic papillopathy (DP) is characterized by optic disc edema but an absence of optic nerve dysfunction, normal intracranial pressure, a lack of nerve inflammation, infiltration or infection [, and no afferent pupillary defects (APD) or dyschromatopsia. (FJ, 2008)

Anterior Ischemic Optic Neuropathy : Anterior ischemic optic neuropathy (AION) is clinically classified as an acute, pallid optic disc swelling (followed by optic nerve pallor) with APD associated with visual field defects telangiectasia of disc vessels may occur, which may be mistaken for disc neovascularization. AION is thought to be precipitated by circulatory insufficiency in nonarteritic ischemic optic neuropathy (NAION) . Diabetic patients are at increased risk of developing NAION. (FJ, 2008)

2.4 Eye Investigation:

2.4.1 Physical Examination of the Eye:

The initial examination of the eye should assess symmetry, conformation, and gross lesions; the eye should be viewed from 2–3 ft (~1 m) away, in

good light, and with minimal restraint of the head. The anterior ocular segment and pupillary light reflexes are examined in detail with a strong light and under magnification in a darkened room. Baseline tests like the Schirmer tear test, fluorescein staining, and tonometry (intraocular pressure measurement) may be followed by ancillary tests such as taking corneal and conjunctival cytology and cultures, everting the eyelids for examination, and flushing the nasolacrimal system to evaluate the external parts of the eye, including the anterior segment. Diseases of the vitreous and ocular fundus are evaluated by direct and indirect ophthalmoscopy (usually performed after inducing mydriasis) and vision testing (menace reflex, obstacle course, dazzle reflex, etc).

2.4.2 Laboratory investigations

Purpose: To review our experiences on the laboratory investigations of viral and chlamydial conjunctivitis, congenital cataract and acute retinal inflammations

2.4.3 Radiological investigations:

2.4.3.1 Orbital X-ray:

Orbital X-ray, or orbital radiography, is used to detect problems resulting from injury or trauma to the eye. Seventy percent of all facial fractures involve the orbits in some way. An x ray of the orbits may also be ordered for patients complaining of pain, vision trouble, or excessive tearing of the eyes. An ophthalmologist may also order orbital x rays when a foreign body cannot be detected with an ophthalmoscope. Orbital x ray is also used as a screening tool before an MRI is performed, since intraorbital metallic foreign bodies are a contraindication for MRI. (Pfirrmann,2001)

2.4.3.2 Ultrasound:

An eye and orbit ultrasound uses high-frequency sound waves to measure and produce detailed images of your eye and eye orbit (the socket in your skull that holds your eye). This test provides a much more detailed view of the inside of your eye than a routine eye exam. (Pfirrmann,2001)

2.4.3.3 Orbit CT scan:

A computed tomography (CT) scan of the orbit is an imaging method. It uses x-rays to create detailed pictures of the eye sockets (orbits), eyes and surrounding bones. (Pfirrmann,2001)

2.4.3.4 Magnetic resonance imaging (MRI):

2.4.3.4.1Principle of MRI:

The basis of MRI is the directional magnetic field, or moment, associated with charged particles in motion. Nuclei containing an odd number of protons and/or neutrons have a characteristic motion or precession. Because nuclei are charged particles, this precession produces a small magnetic moment. When a human body is placed in a large magnetic field, many of the free hydrogen nuclei align themselves with the direction of the magnetic field. The nuclei precess about the magnetic field direction like gyroscopes. This behavior is termed Larmorprecession. (Pfirrmann,2001) In a 1.5 T magnetic field at room temperature this difference refers to only about one in a million nuclei since the thermal energy far exceeds the energy difference between the parallel and ant parallel states. Yet the vast quantity of nuclei in a small volume sum to produce a detectable change in field. Most basic explanations of MRI will say that the nuclei align parallel or anti-parallel with the static magnetic field; however, because of quantum mechanics quantum mechanical reasons, the individual nuclei are actually set off at an angle from the direction of the static magnetic field. The bulk

collection of nuclei can be partitioned into a set whose sum spin are aligned parallel whose sum spin are anti-parallel. (Pfirrmann,2001)

2.4.3.4.2 Equipment of MRI:

The MRI equipment consists of following components: The magnet generates the magnetic field. Shim coils make the magnetic field homogeneous. Radio frequency coils transmit the radio signal into the body part being imaged. Receiver coils detect the returning radio signals. Gradient coils provide spatial localization of the 18 signals. Shielding coils produce a magnetic field that cancels the field from primary coils in regions where it is not desired. The computer reconstructs the signals into the image. The MRI scanner room is shielded by a faraday shield. Different cooling systems cool the magnet, the scanner room and the technique room. (Pfirrmann,2001)

2.4.3.4.3 Magnet:

The magnet is the largest and most expensive component of the scanner, and the remainder of the scanner is built around it. The strength of the magnet is measured in Teslas (T). Clinical magnets generally have field strength in the range 0.1–3.0 T. Three types of magnet have been used: 1-Permanent magnet: Conventional magnets made from ferromagnetic materials. 2-Resistive electromagnet: A solenoid wound from copper wire is an alternative to a permanent magnet. 3-Superconducting electromagnet: most common type found in MRI scanners today. (Pfirrmann,2001)

2.4.3.4.3.1 Radio frequency(RF) system

The RF transmission system consists of a RF synthesizer, power amplifier and transmitting coil. This is usually built into the body of the scanner. The power of the transmitter is variable, but high-end scanners may have a peak output power of up to 35 kW, and be capable of sustaining average power of

1 kW. The receiver consists of the coil, pre-amplifier and signal processing system. (Pfirrmann,2001)

A recent development in MRI technology has been the development of sophisticated multi-element phased array coils which are capable of acquiring multiple channels of data in parallel. This 'parallel imaging' technique uses unique acquisition schemes that allow for accelerated imaging, by replacing some of the spatial coding originating from the magnetic gradients with the spatial sensitivity of the different coil elements. However the increased acceleration also reduces SNR and can create residual artifacts in the image reconstruction. Two frequently used parallel acquisition and reconstruction schemes are sense. (Pfirrmann,2001)

2.4.3.4.3.2 Coils:

A Coil are part of the hardware of MRI machines and are used to create a magnetic field by voltage induced in the wire, coil consists of one or more loops of conductive wire, looped around the core of the coil. (Pfirrmann,2001)

Different types of MRI coils are used in MR systems:

2.4.3.4.3.2.1 Surface Coil:

Is essentially a loop of conducting material, This typeofreceiver coil is placed directly on or over the region of interest for increased magnetic sensitivity.(Pfirrmann,2001)

2.4.3.4.3.2.2Volume Coil:

That surrounds either the whole body, or one specific region, such as the head or a knee. Volume coils have a better RF homogeneity than surface coils, which extends over a large area.(Pfirrmann,2001)

2.4.3.4.3.2.3 Gradient Coil:

Current carrying coils designed to produce a desired magnetic field gradient, Gradient coils in general vary the main magnetic field, so that each signal can be related to an exact location. (Pfirrmann,2001)

2.4.3.4.4 The Orbit MRI:

The Orbit MRI is similar to the brain MRI with additional images specific to the eyes. This type of exam requires an injection of contrast. The contrast agent used by Elliot MRI is called Gadavist and requires that an IV be started in either your arm or hand. After the safety screening has been completed you will be provided a locker where you can safely lock your valuables. We encourage you to leave as many valuables as possible at home. MRI Safe clothing will be provided for you. (Catherine, 2008)

2.4.3.4.4.1 MRI Orbit Protocol

Coronal STIR Orbits

Coronal T2/T1 Fat Sat Orbits

Axial T2 Fat Sat Orbits

Axial T1 Orbits

Sagital T2 Fat Sat orbits(Parallel to optic nerve)

POST CONTRAST "MRI ORBIT PROTOCOL"

POST AX T1 Brain

POST COR T1 Fat Sat

POST AX T1 Orbits (Catherine, 2008)

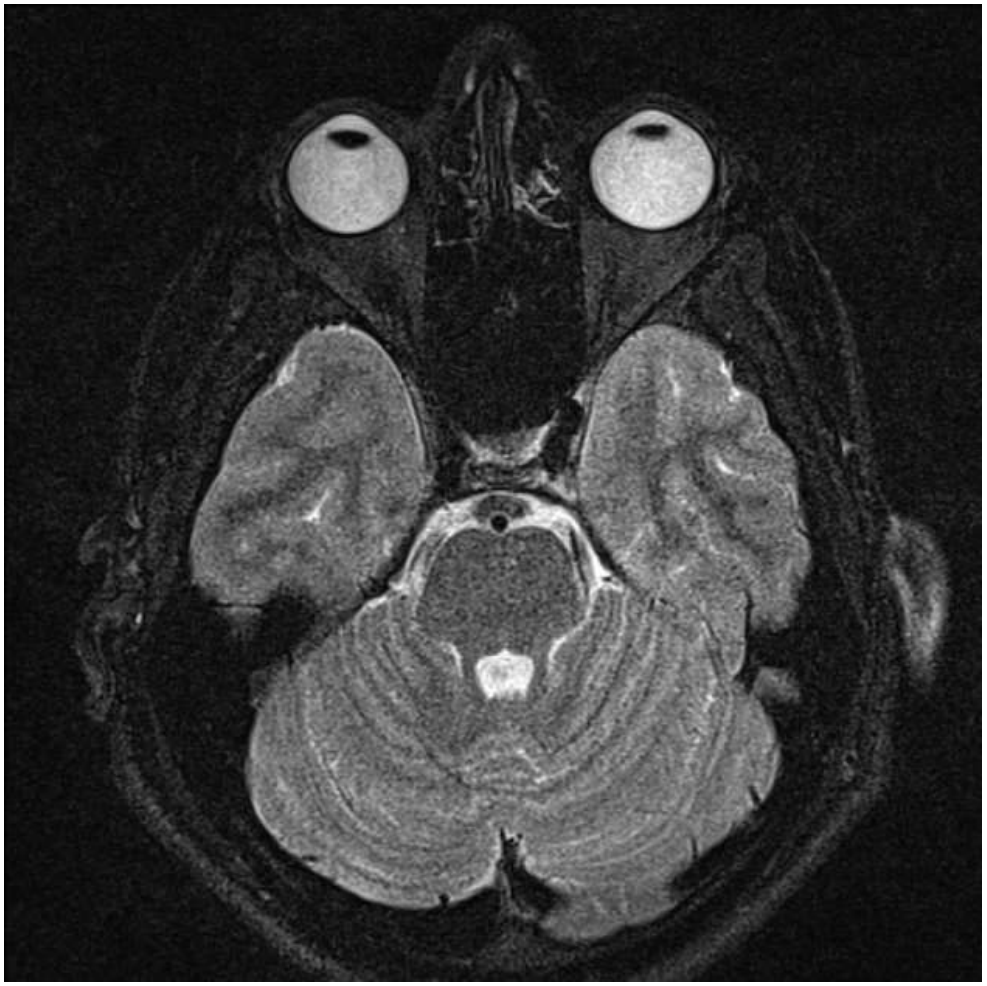

Figure (2.7): Normal MRI Orbit (Catherine, 2008)

2-5 : Previous studies:

Benevento , eltal 2011 studied Optic Nerve Measurements in Normal Human Eyes by MRI and they used Coronal MRI imaging of normal human eyes it's showed an average ONSD range of 4.0 – 6.0 with SD 0.5mm, and an average OND range of 2.6 – 4.0 with SD 0.3mm. there range is consistent with published data on the ONSD. However, we are not aware of any published data on the OND.

Brex , eltal 2011 describe an MRI technique for quantifying optic nerve atrophy resulting from a single episode of unilateral optic neuritis. They imaged 71 patients, with a median time since onset of optic neuritis

Of 17months (range 3– 17months), using a coronal-oblique fat-saturated short-echo fast fluid-attenuated inversion-recovery (STE\FLAIR) sequence. The mean cross-sectional area of the intraorbital portion of the optic nerves was calculated by a blinded observer from five consecutive 3 mm slices from the orbital apex forwards using a semiautomated contouring technique and compared with data from71controls. The mean optic nerve area was 77mm in the affected eye of the patients, 71mm 1in the contralateral eye (P =.1..0compared to the affected eye) and 71mm in controls (P = .1.3compared to the affected eyes). There was a significant negative correlation between disease duration and the size of the affected optic nerve (r = –.1.1, P = .1.71). The measurement coefficient of variation was811%.The STE\ FLAIR sequence enables measurement of optic nerve area with sufficient reproducibility to show optic nerve atrophy following a single episode of unilateral optic neuritis. The correlation of increasing optic nerve atrophy With disease duration would be consistent with ongoing axonal loss in a persistently demyelinated lesion, or Wallerian degeneration following axonal damage during the acute inflammatory phase.

Indian J Crit Care Med 2015 Aug 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, they found acceptable agreement between both methods for measurements at a depth of 3 mm (r = 0.02, $P < 0.001$).

Chapter three

Materials and methods

Chapter three

Materials and Methods

3-1 : Material:

3-1-1 : Study Population:

50 Patients were examined (30 of them had diabetes and 20 as control croup in both genders) their ages range between 30 – 90 years old all of them did MRI orbits.

3-1-2 : Area, duration of the study and data analysis:

The study has been carried out in Khartoum state during the period September 2019 to February 2020**.** In Dar Alelaj specialized Hospital, Khartoum state.

3-2 : Methods:

The patient lies supine on the examination couch. Both orbits are examined. Used head coil, these are placed over-each orbit but should not touch the patient. The patients are positioned so that the longitudinal alignment light lies in the midline and the horizontal alignment light passes through the orbits Straps and foam padsare used for immobilization. (Catherine, 2008)

3-3 : Used Machine and Methods of measurements:

Philips 1.5 Tesla Gradient options performance values, performance TQ System type Trio Max. Gradient field (X/Y/Z) 40/40/45 mT/m Min. rise time 200 μse c.(0 - 40 mT/m)Slew rate200 T/m/s Max. Gradient current 625 A Max. voltage(across Gradient Coil)2000 V Gradient Coil AS 092[Philips ingenia products corporation .inc]

By measuring the highest area of the optic chiasm and the length of the optic nerve (the area from the posterior part of the eye ball to the optic chiasm) and the area between the two borders of optic canal (widths of the optic nerve).

3-4 : Used protocols :

Sagittal oblique T**2** Tr 5000 Te 105 for the length .
Coronal T**2** Tr 5000 Te 105 for the widths .

3-5 : Orbit Imaging technique:

In order to imaging the optic nerve we usually use Computed Tomography (CT) or Magnetic Resonance Imaging (MRI)

3-5-2 : Orbit MRI technique :

3-5-2-1 Common indications:

Proptosis .

Visual disturbance.

Evaluation of orbital or ocular mass lesion. (Shlomo et al, 2011)

3-5-2-2 Equipment :

Small surface coil for globe and orbit ,Quadrature head coil for orbital apex, chiasm and intra-cranial optic pathways, Immobilization straps and foam pads. (Shlomo et al, 2011)

3-5-3 : Suggested protocols:

- Axial SE T1
- Coronal SE T1
- Sagittal SE T1

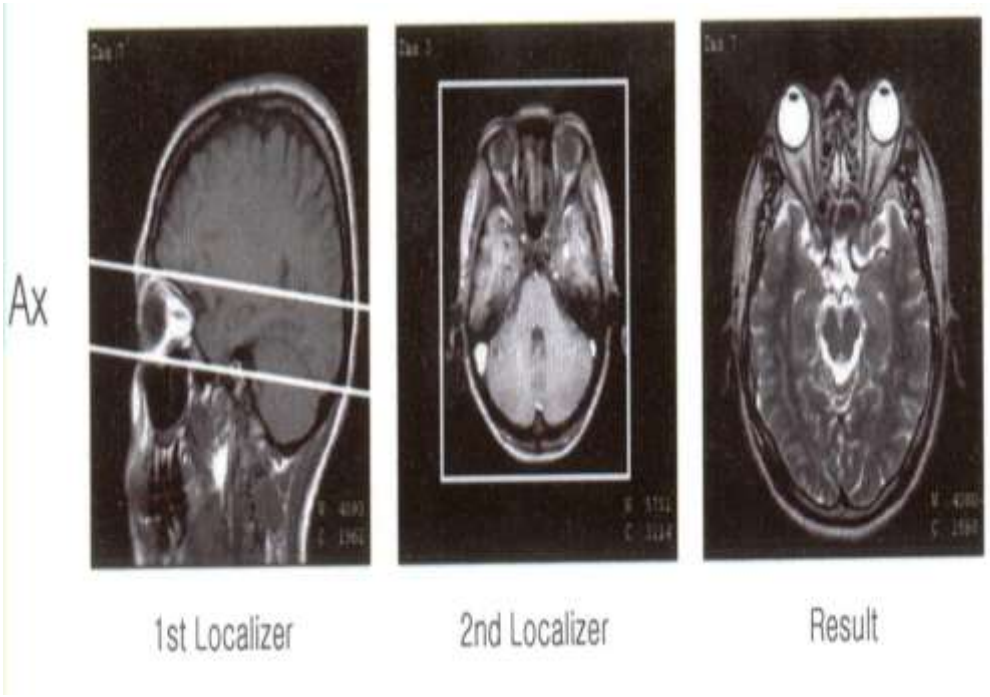

Figure number (3-1) shows the Axial scan [Westbrook, 2008]

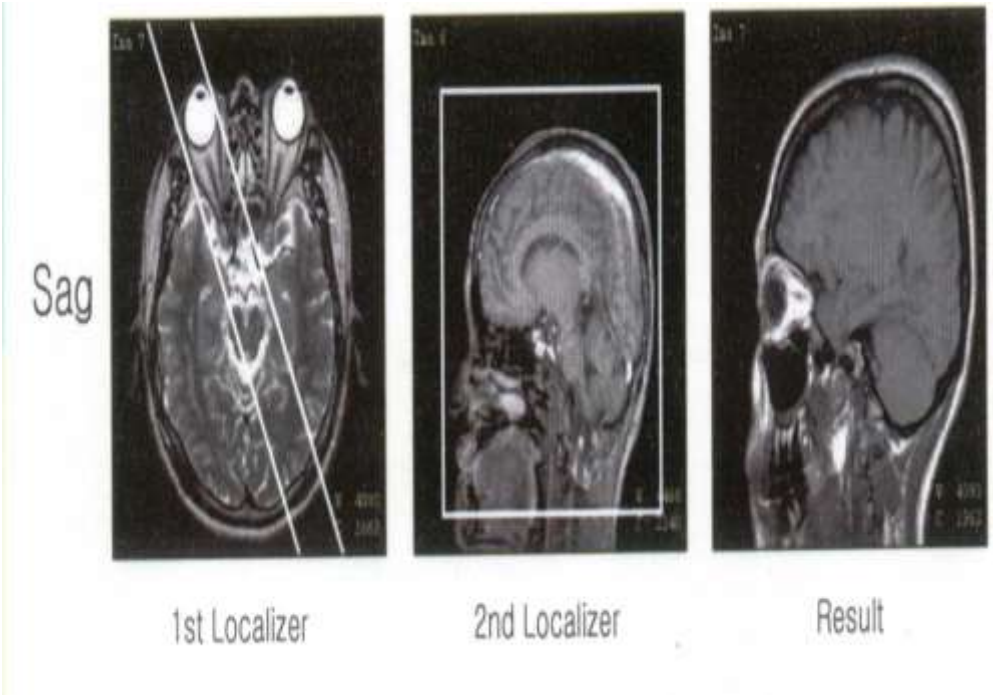

Figure number (3-2) shows the Sagittal scan[Westbrook, 2008]

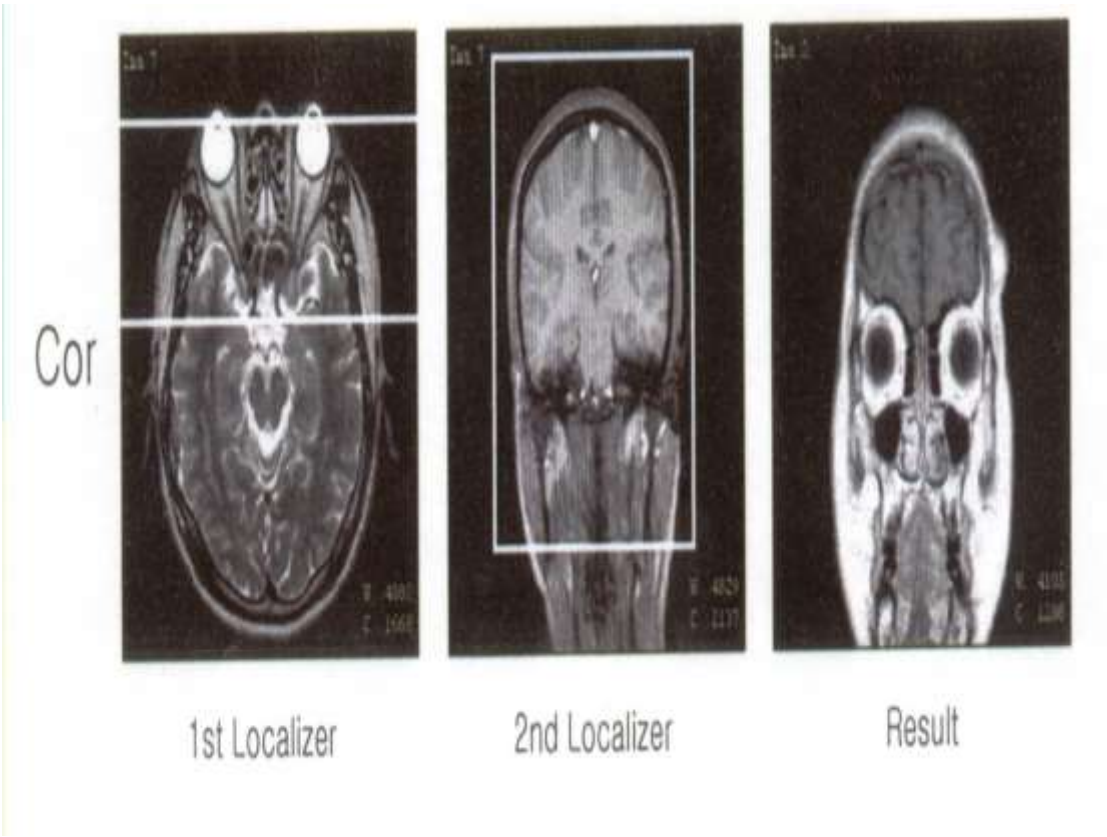

Figure number (3-3) shows the Coronal scan [Westbrook, 2008]

Chapter Four

Results

Chapter Four

Results

The following tables and figures represented the data obtained from 30 patients who were examined for sagittal and coronal MRI for orbits, the optic nerve width and length was measured and the optic chiasm width and length has measured too , patients age gender , diabetes duration have also been examined. The data was analyzed using SPSS version 20 for significances of tests. Frequency tables mean and standard deviations were presented.

All the following measurements in centimeter.

4-1: Optic nerve measurements:

Table no (4-1) shows the duration of diabetes among diabetic patients and control group:

	Number	Minimum	Maximum	Mean	Std. Deviation
age Cases	30	34	85	62.67	15.345
age Control	20	30	85	52.8	15.913
Duration of diabetes	30	10	35	21.77	8.386

Table no (4-2) shows distribution of gender among diabetic patients and control group:

	Case		Control	
	Frequency	**Percent**	**Frequency**	**Percent**
Male	15	50	12	60
Female	15	50	8	40
Total	**30**	**100**	**20**	**100**

Table no (4-3) shows types of diabetes:

	Frequency	**Percent**
Type 1	20	66.7
Type 2	10	33.3
Total	**30**	**100**

Table no (4-4) shows mean of measurements for the right/left sagittal and right/left coronal of the optic nerve among diabetic patients:

		Number	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Right	sagittal measurements	30	2.6	3.1	2.867	0.1269
	Coronal measurements	30	0.3	0.4	0.343	0.0504
Left	Sagittal measurements	30	2.6	3.1	2.85	0.1432
	Coronal measurements	30	0.3	0.4	0.343	0.0504

Table no (4-5) shows mean of measurements for the right/left sagittal and coronal of the optic nerve among Control group:

		Number	Minimum	Maximum	Mean	Std. Deviation
Right	sagittal measurements	20	2.9	3.6	3.27	0.2296
	Coronal measurements	20	0.4	0.6	0.49	0.0852
Left	sagittal measurements	20	2.9	3.6	3.27	0.2296
	Coronal measurements	20	0.4	0.6	0.49	0.0852

Table no (4-6) shows comparison of the right sagittal and right coronal measurements of the optic nerve between males and females:

		Number	Mean	Std. Deviation	P value	Comment
sagittal measurements	Male	27	3.052	0.2694	0.495	Insignificant
	Female	23	3	0.2611		
Coronal measurements	Male	27	0.404	0.098	0.896	Insignificant
	Female	23	0.4	0.1		

Table no (4-7) shows comparison of the left sagittal and left coronal measurements of the optic nerve between males and females:

		Number	Mean	Std. Deviation	P value	Comment
sagittal measurements	Male	27	3.033	0.2909	0.674	Insignificant
	Female	23	3	0.2611		
Coronal measurements	Male	27	0.404	0.098	0.896	Insignificant
	Female	23	0.4	0.1		

Table no (4-8) shows comparison of the right sagittal and right coronal of the optic nerve between diabetic patients and control:

		Number	Mean	Std. Deviation	P value	Comment
sagittal measurements	Case	30	2.867	0.1269	0.000	Significant
	Control	20	3.27	0.2296		
Coronal measurements	Case	30	0.343	0.0504	0.000	Significant
	Control	20	0.49	0.0852		

Table no (4- 9) shows comparison of the left sagittal and left coronal in optic nerve between diabetic patients and control group:

		Number	Mean	Std. Deviation	P value	Comment
sagittal measurements	Case	30	2.85	0.1432	0.000	Significant
	Control	20	3.27	0.2296		
Coronal measurements	Case	30	0.343	0.0504	0.000	Significant
	Control	20	0.49	0.0852		

Table no (4- 10) shows comparison of the right sagittal and right coronal of the optic nerve between types of diabetes:

		Number	Mean	Std. Deviation	P value	Comment
sagittal measurements	Type 1	20	2.885	0.1182	0.27	Insignificant
	Type 2	10	2.83	0.1418		
Coronal measurements	Type 1	20	0.35	0.0513	0.314	Insignificant
	Type 2	10	0.33	0.0483		

Table no (4-11) shows comparison of the left sagittal and left coronal of the optic nerve between types of diabetes:

		Number	Mean	Std. Deviation	P value	Comment
Sagittal measurements	Type 1	20	2.86	0.1465	0.598	Insignificant
	Type 2	10	2.83	0.1418		
Coronal measurements	Type 1	20	0.35	0.0513	0.314	Insignificant
	Type 2	10	0.33	0.0483		

Table no (4-12) shows association of the right sagittal and right coronal of the optic nerve with age and duration of disease:

	Pearson Correlation	P value	Comment
sagittal measurements and age	-0.411	0.003	Significant Negative
sagittal measurements and duration	-0.601	0.000	Significant Negative
Coronal measurements and age	-0.406	0.003	Significant Negative
Coronal measurements and duration	-0.391	0.032	Significant Negative

Table no (4-13) shows association of the left sagittal and left coronal of the optic nerve with age and duration of disease:

	Pearson Correlation	**P value**	**Comment**
sagittal measurements and age	-0.405	0.004	Significant Negative
sagittal measurements and duration	-0.530	0.003	Significant Negative
Coronal measurements and age	-0.406	0.003	Significant Negative
Coronal measurements and duration	-0.391	0.032	Significant Negative

4-2:Optic chiasm measurements:

Table no (4-14) shows the duration of diabetes among patients:

	Number	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
age Cases	30	34	85	62.67	15.345
age Control	20	30	85	52.8	15.913
Duration of diabetes	30	10	35	21.77	8.386

Table no (4-15) shows distribution of gender among diabetic patients and control:

	Case		**Control**	
	Frequency	**Percent**	**Frequency**	**Percent**
Male	15	50	12	60
Female	15	50	8	40
Total	30	100	20	100

Table no (4-16) shows mean of measurements for the right and left optic chiasm in sagittal and coronal among diabetic patients:

		Number	Minimum	Maximum	Mean	Std. Deviation
Right	sagittal measurements	30	2.6	3.1	2.867	0.1269
	Coronal measurements	30	0.3	0.4	0.343	0.0504
Left	sagittal measurements	30	2.6	3.1	2.85	0.1432
	Coronal measurements	30	0.3	0.4	0.343	0.0504

Table no (4-17) shows mean of measurements for the right and left optic chiasm in sagittal and coronal among Control group:

		Number	Minimum	Maximum	Mean	Std. Deviation
Right	sagittal measurements	30	2.6	3.1	2.867	0.1269
	Coronal measurements	30	0.3	0.4	0.343	0.0504
Left	sagittal measurements	30	2.6	3.1	2.85	0.1432
	Coronal measurements	30	0.3	0.4	0.343	0.0504

Table no (4-18) shows comparison of the right sagittal and right coronal in optic chiasm between males and females:

		Number	Mean	Std. Deviation	P value	Comment
sagittal measurements	Male	27	3.052	0.2694	0.495	Insignificant
	Female	23	3	0.2611		
Coronal measurements	Male	27	0.404	0.098	0.896	Insignificant
	Female	23	0.4	0.1		

Table no (4-19) shows comparison of the left sagittal and left coronal optic chiasm between males and females:

		Number	Mean	Std. Deviation	P value	Comment
sagittal measurements	Male	27	3.033	0.2909	0.674	Insignificant
	Female	23	3	0.2611		
Coronal measurements	Male	27	0.404	0.098	0.896	Insignificant
	Female	23	0.4	0.1		

Table no (4-20) shows comparison of the right sagittal and right coronal optic chiasm between diabetic patients and control group:

		Number	Mean	Std. Deviation	P value	Comment
sagittal measurements	Case	30	2.867	0.1269	0.000	Significant
	Control	20	3.27	0.2296		
Coronal measurements	Case	30	0.343	0.0504	0.000	Significant
	Control	20	0.49	0.0852		

Table no (4-21) shows comparison of the left sagittal and left coronal optic chiasm between diabetic patients and control group:

		Number	Mean	Std. Deviation	P value	Comment
sagittal measurements	Case	30	2.85	0.1432	0.000	Significant
	Control	20	3.27	0.2296		
Coronal measurements	Case	30	0.343	0.0504	0.000	Significant
	Control	20	0.49	0.0852		

Table no (4-22) shows comparison of the right sagittal and right coronal optic chiasm between types of diabetes:

		Number	Mean	Std. Deviation	P value	Comment
sagittal measurements	Case	30	2.867	0.1269	0.000	Significant
	Control	20	3.27	0.2296		
Coronal measurements	Case	30	0.343	0.0504	0.000	Significant
	Control	20	0.49	0.0852		

Table no (4-23) shows comparison of the left sagittal and left coronal optic chiasm between types of diabetes:

		Number	Mean	Std. Deviation	P value	Comment
Sagittal measurements	Type 1	20	2.86	0.1465	0.598	Insignificant
	Type 2	10	2.83	0.1418		
Coronal measurements	Type 1	20	0.35	0.0513	0.314	Insignificant
	Type 2	10	0.33	0.0483		

Table no (4-24) shows association of the right sagittal and right coronal optic chiasm with age:

	Pearson Correlation	**P value**	**Comment**
sagittal measurements and age	-0.411	0.003	Significant Negative
Coronal measurements and age	-0.406	0.003	Significant Negative

Table no (4-25) shows association of the left sagittal and left coronal optic chiasm with age:

	Pearson Correlation	**P value**	**Comment**
sagittal measurements and age	-0.405	0.004	Significant Negative
Coronal measurements and age	-0.406	0.003	Significant Negative

Chapter Five

Discussion, Conclusion & Recommendations

Chapter five

The discussion, Conclusion and Recommendations

5-1: Discussion:

The effect of diabetes on optic nerve and optic chiasm analyzed by MRI for orbits(30) diabetic patients Compared to 20 as control group) statistical significance was demonstrated regarding.

5-1-1:Optic nerve:

Table (4.1) showed the number of cases and its distribution to 30 diabetic patients and 20 as control group.

Table (4-2) showed the distribution of gender in diabetic patients in to 15 male and 15 female.

Table (4-3)showed types of diabetes type1and type 2.

Table (4-4) and table (4-5) showed the measurements for the right/left sagittal And right/left Coronal among diabetic patients and control group. the mean of the right sagittal measurements in diabetic patients was 2.867 and the Std deviation is 0.126 and the mean of the right coronal measurements in diabetic patients was 0.343 and the standard deviation was 0.0504 . The left sagittal measurements was 2.85 std deviation was 0.1432. The mean of the Coronal measurements was 0.343 std deviation 0.0504. The control group measurements mean for the right sagittal was 3.27 and std deviation 0.2296. The right coronal was 0.49 and std deviation 0.0852. The left sagittal was 3.27 and std deviation 0.2296. the left coronal mean was 0.49 and std deviation

0.0852.therefore the mean measurement of the optic nerve in diabetic patients was less than control group (2.867 to 3.27 in sagittal , 0.343 to 0.49 in coronal).

Table no (4-6) and table no (4-7) showed the comparison of the right/left sagittal and coronal between males and females. The P-value of the sagittal measurements between the males and females was 0.4495. When the coronal measurements was 0.896. the measurements was insignificant in both genders which means the gender has no effect on diabetes.

Table no (4-8) and table no (4-9) showed a comparison of a right/left sagittal and coronal between diabetic patients and the control group when P-value in both diabetic patients and control group was 0.000 which means there is a significant difference.

Table no (4-10) and (4-11) showed a comparison of the right/ left sagittal and coronal in optic nerve between types of diabetes. The P-value in the right sagittal measurements between type 1 and type 2 was 0.27 and the P-value of the right coronal measurements between type 1 and type 2 was 0.314.

The P-value in the left sagittal measurements between type 1 and type 2 was 0.598 and the P-value of the left coronal measurements between type 1 and type 2 was 0.314. The study of both types showed an insignificant measurement in both types which means that optic nerve affected in both types.

Table no (4-12) and table (4-13) showed the association of the right/left sagittal and coronal of the optic nerve with age and duration of disease. The Pearson correlation on both right and left sagittal and coronal was a

significant negative which means that When the duration of diabetic increased the measurements of the optic nerve decreased.

All results above same to (P A, 2017) archived results.

5-1-2:Optic chiasm:

Table no (4-14) showed the duration of diabetes among patients. Mean age of cases 62.67 (std. Deviation 15.35) means that the distribution of age in the case group fall around age 62.67 years plus or minus the 15.34 years (standard deviation), in others way age of cases fall between 47.33 and 78 years.

Table no (4-15) showed distribution of gender among diabetic patients and control group.

Table no (4-16) and table (4-17) showed the measurements for the right/left sagittal and right/left Coronal among diabetic patients and control group. the mean of right the sagittal measurements in diabetic patients was 2.867 and the std deviation was 0.1269 and The mean of the right coronal Measurements in diabetic patients was 0.343 and the standard deviation was 0.0504 . The left measurements for sagittal was 2.85 std deviation was 0.1432. The mean of the left Coronal measurements was 0.343 std deviation 0.0504. The control group measurements mean for the right sagittal was 3.27 and std deviation 0.2296. the right coronal was 0.49 and std deviation 0.0852. The left sagittal was 3.27and std deviation 0.2296. The left coronal mean was 0.49 and std deviation 0.0852.

Table no (4-18) and (4-19) showed comparison of the left/right sagittal and coronal optic chiasm between males and females. The P-value of the ***left*** sagittal measurements was 0.674. When the coronal measurements was

0.896. The P-value of the right sagittal measurements was 0.495. When the coronal measurements was 0.896.The measurements was insignificant in both genders which means the gender has no effect on diabetes.

Table no (4-20) and table (4-21) showed a comparison of a right/left sagittal and coronal between diabetic patients and the control group when P-value in both diabetic patients and control group was 0.000 which means there is a significant difference.

Table no (4-22) and (4-23) showed a comparison of the right/ left sagittal and coronal in optic chiasm between types of diabetes. The P-value in the right sagittal and right coronal measurements was 0.000. The P-value in the left sagittal measurements between type 1 and type 2 was 0.598 and the P-value of the left coronal measurements between type 1 and type 2 was 0.314. which means there is insignificant difference.

Table no (4-24) and table (4-25) showed the association of the right/left sagittal and coronal of the optic chiasm with age and duration of disease. The Pearson correlation on both right and left sagittal and coronal was a significant negative which means that when the duration of diabetic increased the measurements of the optic chiasm decreased.
All results above same to (P A, 2017) archived results.

5-2: The Conclusion:

Diabetes affects the optic nerve and the optic chiasm.

The study found that in a comparison between males and females in the measurement of the optic nerve and the optic chiasm, the results was insignificant which means the diabetes has no effect on gender.

In a comparison between types of diabetic there were also insignificant results.

In a comparison between diabetic patients and control group there was a significant different in measurements of the optic nerve and the optic chiasm.

The patient age affect the optic nerve and optic chiasm diameter in length and widths.

The gender has no effect on the optic nerve or optic chiasm diameter in diabetic patient.

When the duration of diabetic increased the measurements of the optic nerve decreased.

Globally, as of 2013, an estimated 382 million people have diabetes worldwide, with type 2 diabetes making up about 90 % of the cases. This is equal to 3.3 % of the population, with equal rates in both women and men. In 2011 diabetes resulted in 1.4 million deaths worldwide, making it the 8 the leading cause of death. The number of people with diabetes is expected to rise to 592 million by 2035.

5-3 :The Recommendations:

Prevention is better than cure by being in a normal body weight, physical exercise, and following a healthy diet. Dietary changes known to be effective in helping to prevent diabetes include a diet rich in whole grains and fiber and choosing good fats, such as polyunsaturated fats found in nuts, vegetable oils and fish. Limiting sugary beverages and eating less red meat and other sources of saturated fat can also help in the prevention of diabetes. Active smoking is also associated with an increased risk of diabetes, so smoking cessation can be an important preventive measure as well.

Diabetes management concentrates on keeping blood sugar levels as close to normal ("euglycemia") as possible without causing hypoglycemia. This can usually be accomplished with diet, exercise, and use of appropriate medications (insulin in the case of type 1 diabetes; oral medications, as well as possibly insulin, in type 2 diabetes.

Learning about the disease and actively participating in the treatment is vital for people with diabetes, since the complications of diabetes are far less common and less severe in people who have well-managed blood sugar levels.

Attention is also paid to other health problems that may accelerate the deleterious effects of diabetes. These include smoking, elevated cholesterol levels, obesity, high blood pressure, and lack of regular exercise.

Anti-diabetic medication Metformin is generally recommended as a first line treatment for type 2 diabetes, as there is good evidence that it decreases

mortality. Routine use of aspirin, however, has not been found to improve outcomes in uncomplicated diabetes.

More precise measurements may be possible using dedicated multi–plane high resolution MRI images from larger sample size normal volunteers.

More measurements MRI images from larger sample size or diabetes patients.

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The Appendix

The data collection questioner

Name of Hospital:

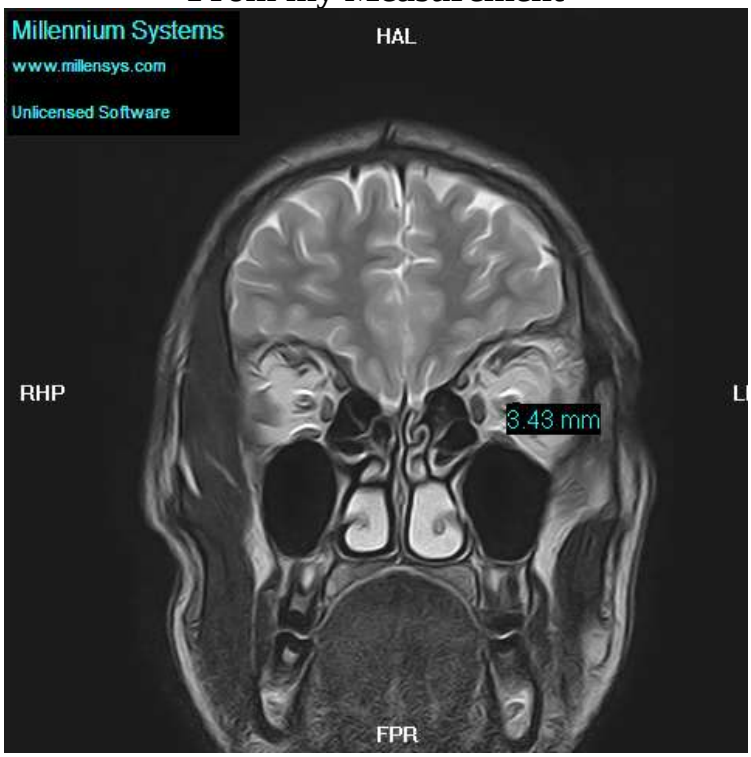
- Dar Alelaj specialized Hospital.

No.	Name	Gender	age	measurement		Type of diabetes	Duration of diabetes	Other finding
				Sagittal	coronal			

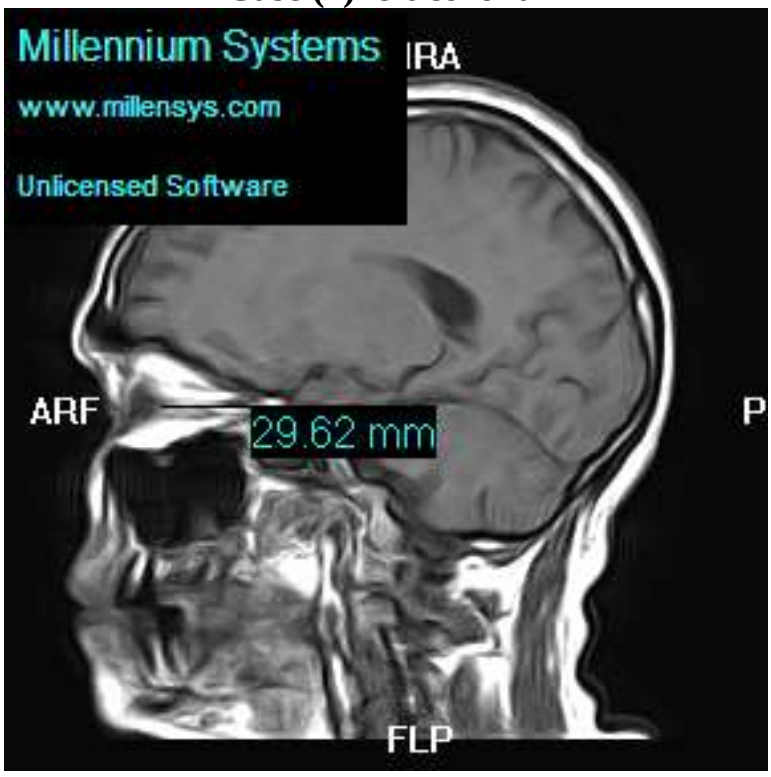
The Control Group Questioner

No.	Name	Age	Gender	Measurements	
				Coronal	Sagittal
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

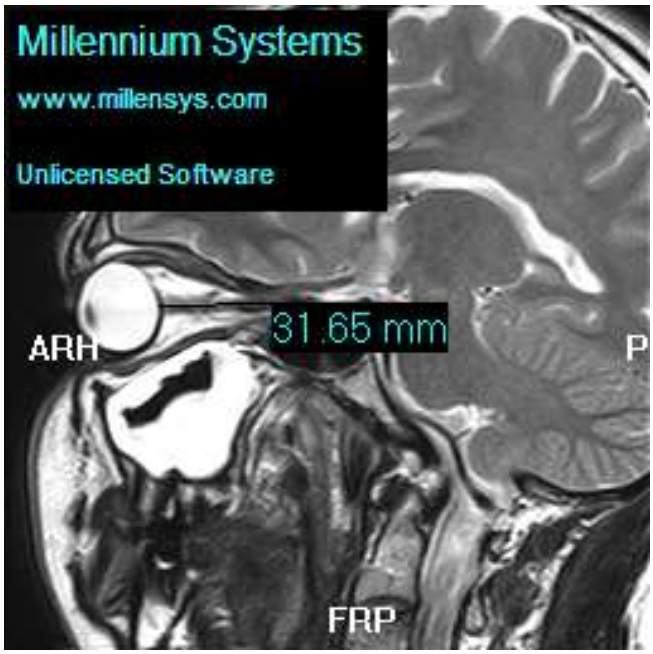
From my Measurement



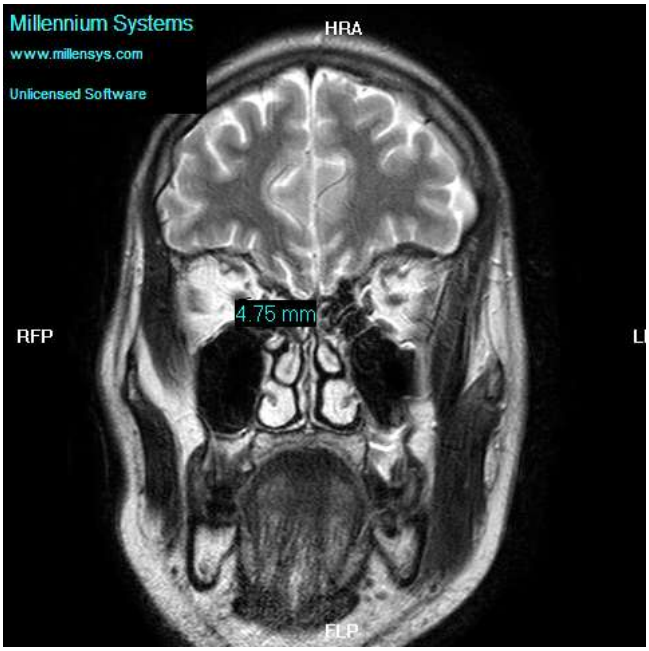
Case (1) left coronal



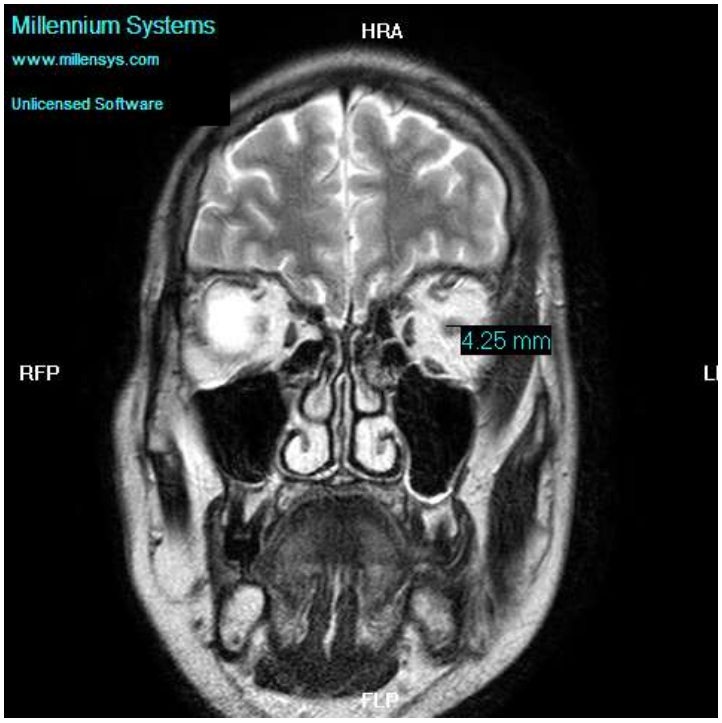
Case (2) right sagittal :



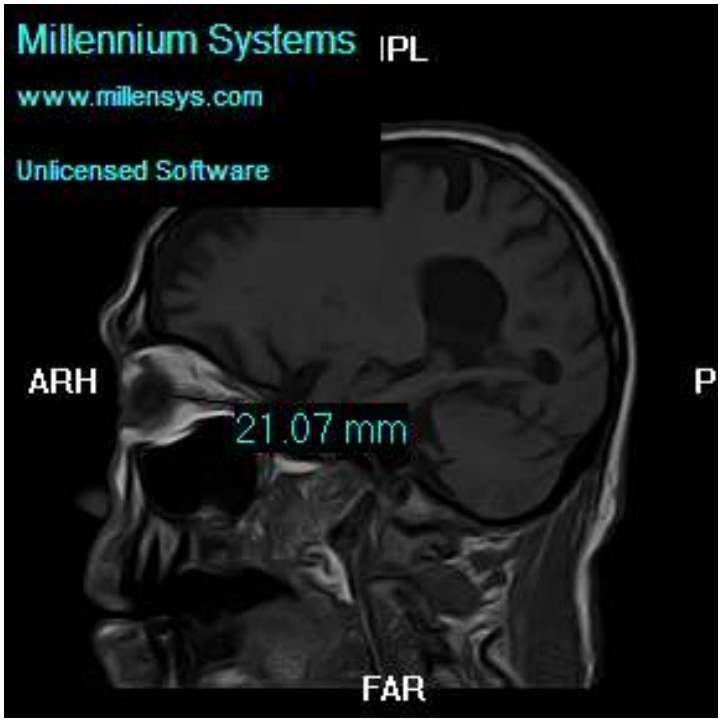
Case (3) left sagittal :



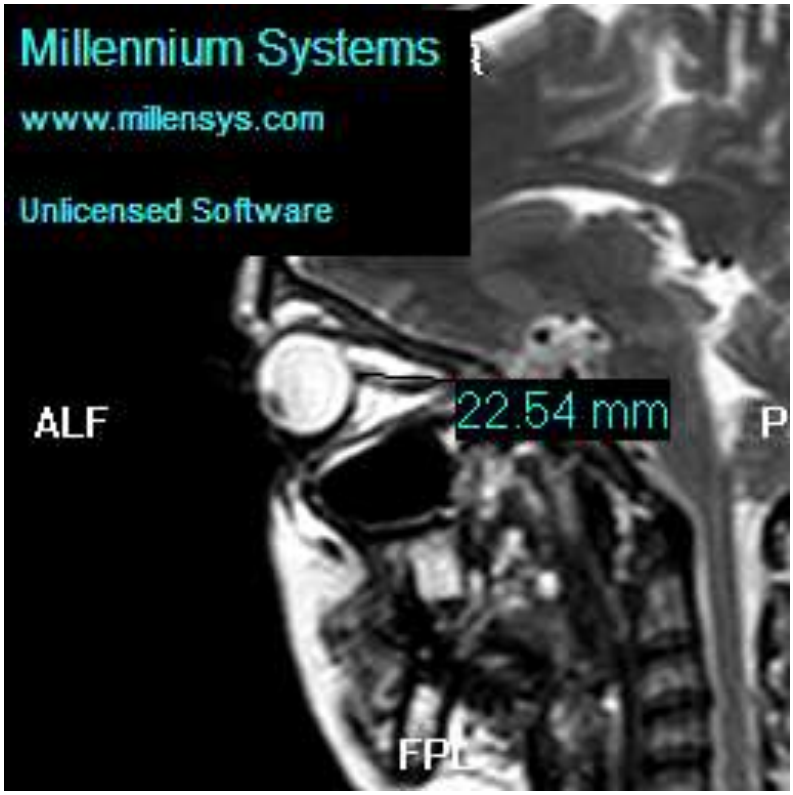
Case (4) right coronal:



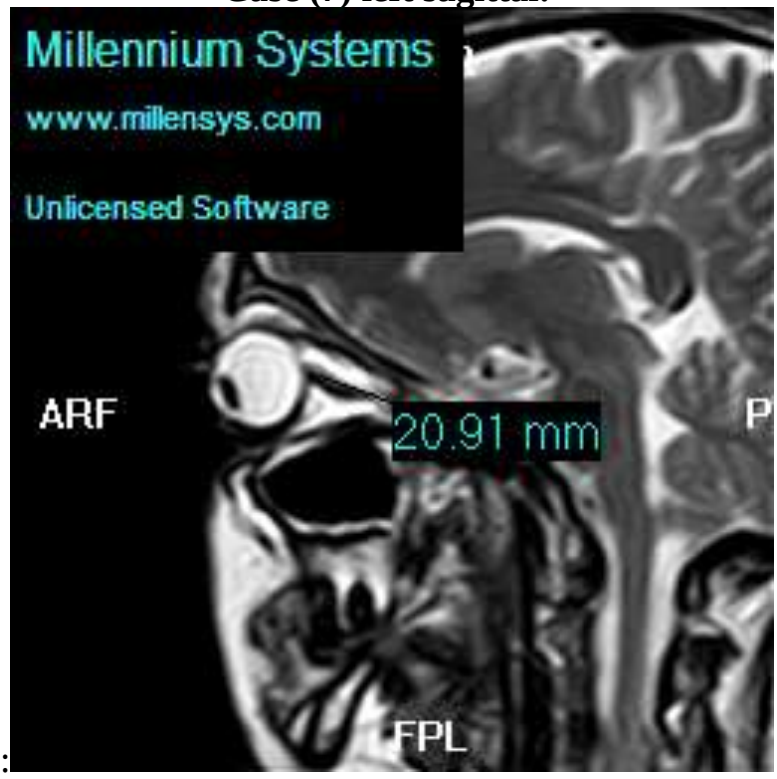
Case (5) lest coronal :



Case (6) right sagittal :



Case (7) left sagittal:



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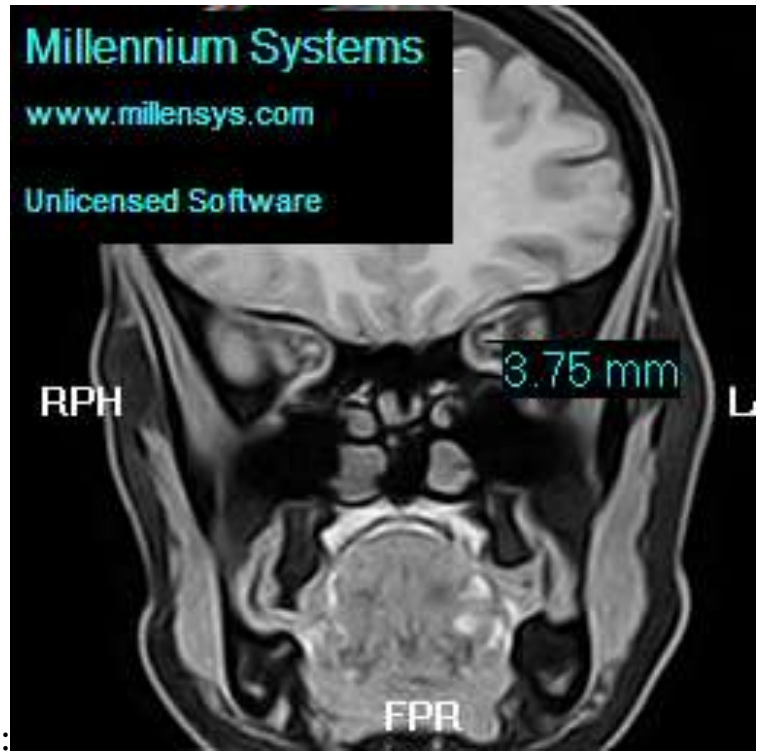
Case (8) right sagittal



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Case (9) left coronal

Case (10) left sagittal :