



بسم الله الرحمن الرحيم

Sudan University of Science and Technology

Collage of Graduate studies



Measurements of Normal Optic Nerve for Adult Sudanese using Magnetic Resonance Imaging

قياس العصب البصري الطبيعي لدي السودانيين البالغين بأستخدام التصوير بالرنين المغنطيسي

A Thesis Submitted for Partial Fulfillment of M.sc Degree in Diagnostic Radiologic Imaging

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الآية

بسم الله الرحمن الرحيم

قال الله تعالى: ﴿الَّذِي خَلَقَ سَبْعَ سَمَاوَاتٍ طِبَاقًا مَّا تَرَى فِي خَلْقِ الرَّحْمَنِ مِنْ تَفَوُّتٍ فَارْجِعِ
الْبَصَرَ هَلْ تَرَى مِنْ فُطُورٍ ﴿٣﴾ ثُمَّ ارْجِعِ الْبَصَرَ كَرَّتَيْنِ يَنْقَلِبْ إِلَيْكَ الْبَصَرُ خَاسِئًا وَهُوَ حَسِيرٌ ﴿٤﴾﴾

الملك: 3-4

صدق الله العظيم

DEDICATION

To my Family..

To my wife..

To my friends who stood beside me and supported me..

Thanks for all ..

ACKNOWLEDGMENT

First and foremost, I would like to express my deepest gratitude to Dr. Asmaa, without her help this work could not been accomplished.

My thanks also go to Abdalrahman Hassan My friend, deep thanks to my family for their consistent mental support, finally I would like to thanks my wife Anfal.

Abstract

Magnetic resonance imaging (MRI) is a spectroscopic imaging technique used in medical to produce images of the human body. MRI is one of the safety diagnostic procedures for measurement of the optic nerve diameter.

This study was conducted to find out the mean optic nerve length and width in Adult Sudanese population using MRI. Number of 50 patients MRI orbit and brain was performed for Sudanese patient there ages between 20–80 years old, were 23 males and 27 females.

The result after data analysis was found the overall mean of optic nerve length was $[4.7105 \pm 0.43099]$ cm, and mean of optic nerve width $[0.3972 \pm 0.09941]$ cm. with minimum length [3.8 cm], and maximum length [5.85 cm].with minimum width [0.28cm], and maximum width [0.56 cm].There is no difference between the dimensions of normal optic nerves in both eyes. There is correlations between the optic nerve length and the patient weight as weight increase the length increase, between the optic nerve length and the patient weight as weight increase the width increase, also there is correlation between length, width with age as age increase the length and width increase and the optic nerve (length & width) slightly higher in males.

المستخلص

التصوير بالرنين المغناطيسي هو أحد تقنيات التصوير الطبي المستخدمة في إنتاج الصور الطبية من داخل جسم الإنسان. وهو أحد وسائل التشخيص الآمنة لقياس قطر العصب البصري. أجريت هذه الدراسة لقياس متوسط طول و عرض العصب البصري الطبيعي في المواطن السوداني البالغ بأستخدام تقنية التصوير بالرنين المغناطيسي، وقد أجرى التصوير لعدد خمسين مريض بواسطة الرنين المغناطيسي للعين و المخ لمواطنين سودانيين ترواحت أعمارهم ما بين العشرين و الثمانين عاماً ، منهم 27 نساء و 23 رجال.

و كانت النتيجة بعد تحليل البيانات كالآتي: المتوسط الكلي لطول العصب البصري كان (4.7105 ± 0.40399) و متوسط العرض كان (0.3972±0.09941) سم، أقل طول كان (3.8) سم و أعلى طول كان (5.85) سم، و أقل عرض كان (0.28) سم و أعلى عرض كان (0.56) سم.

كان هنالك علاقة بين طول العصب البصري و عرضه و الوزن، كل ما زاد الوزن كلما زاد طول و عرض العصب البصري.

وهنالك علاقة بين طول العصب البصري وعرضه و العمر، كل ما زاد العمر كل ما زاد طول و عرض العصب البصري.

طول و عرض العصب البصري أعلى نسبياً عند الرجال من النساء، كما أنه لا يوجد فرق يذكر بين طول العصب البصري في كلتا العينين.

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Chapter one

Introduction

Chapter one

1.1 Introduction:

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 Chiasma (Longman-2003).

Optic Nerve has four portions, they are: intra cranial, intracanalicular, intra orbital and intraocular (Longman-2003).

Although we speak of the optic nerve, it is very important to realis that it is really no nerve at all, but essentially a fiber tract joining two portions of is uncontrollable .They are: It is an outgrowth of the brain, Its fibers possess no neurolemmal cells, It is surrounded by the meninges, unlike any peripheral nerve and both the primary and secondary neurons are in the retina. (Agarwal-2008)

MRI has great value in measurements of the optic nerve. (Longman-2003)

1.2 Problem of the study:

Measurements previously done on computed tomography or other modality rather differ according technique and modality rather than MRI leading to Un accuracy of optic nerve measurement and due to different method of measurement the standard value to optic nerve dimensions among Sudanese people for different age and gender . There for using precise MRI technique and measurement will help in accurate determinations of optic nerve.

1.3 Study objectives:

1.3.1 General objective:

To measure the normal optic nerve dimensions in adult Sudanese using MRI in order to establish the standard measurements for Sudanese people.

1.3.2 Special objectives:

To measure optic nerve dimensions in coronal, axial views.

To test the different of optic nerve among age group, gender, and weight.

1.4 Significant of the study:

This study is important because it is measuring the effectiveness of magnetic resonance imaging device to measure the normal optic nerve dimensions and make a standard values for comparison purposes .

1.5 Research contents:

The study contains five chapters, chapter one consisted of introduction that contain an idea about the optic nerve in Addition to Research problem, Objectives. Chapter two includes the literature review and previous studies. Chapter three describes the material and methods. Chapter four includes the result, chapter five includes the discussion, conclusion, recommendations references and appendix.

Chapter two
Literature review

Chapter two

2.1 Anatomy of the eye:

When you look at a person's eye you see only a small part of the whole eye. Three layers of tissue form the eye ball: the sclera, the choroids, and the retina. The outer layer of sclera consists of tough 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 spoken of 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... (Longman, 2003)

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. (Longman, 2003)

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 can 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 daytime 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. . (Longman, 2003)

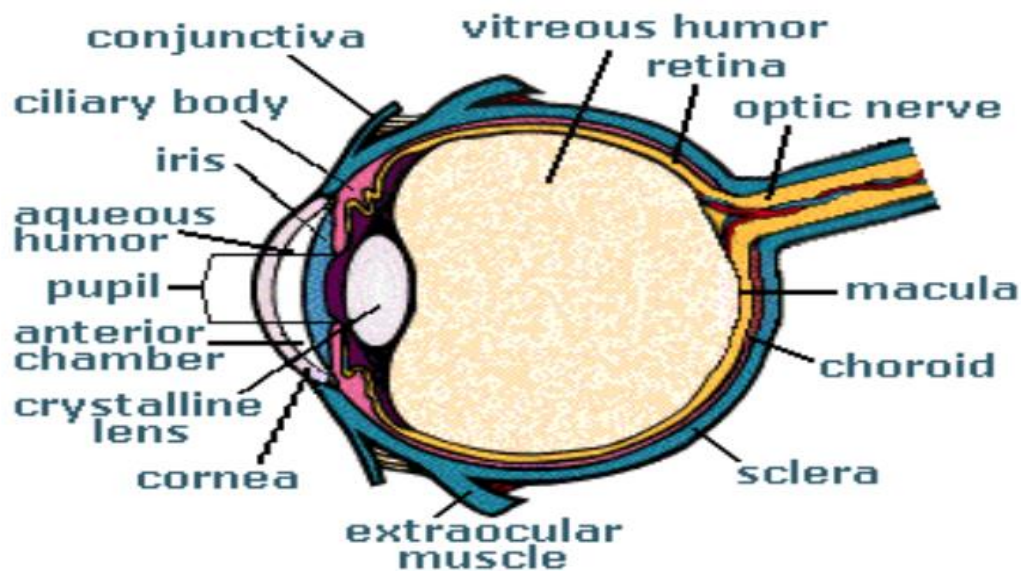


Figure (2-1) shows the Anatomy of the Eye. (Longman, 2003)

2.2 Anatomy of optic nerve:

The optic nerve is 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 chiasma. (Longman et al 2003).

Optic Nerve, or the second cranial nerve has four portions, they are : intra cranial , intracanalicular , intra orbital and intraocular , Although we speak of the optic nerve ,it is very important to realize that it is really no nerve at all ,but essentially a fiber tract joining two portions of is uncontrollable .They are an outgrowth of the brain , Its fibers possess no neurolemmal cells , It is surrounded by the meninges ,unlike any peripheral nerve and both the primary and secondary neurons are in the retina.(Agarwal-2008) .

2.2.1 Intracranial Portion

Optic nerve unsheathed in pia runs as a flattened band from the anterior lateral angle of the somewhat quadrilateral optic chiasma. It runs forwards and the laterally and slightly downwards to the optic foramen. (Agarwal-2008)).

2.2.2 Intracanalicular Portion

At its entry into the optic canal, it receives a covering of arachnoid mater and since the dura mater is prolonged through the canal as aperiosteum, the nerve is in fact from here onwards surrounded by all three meninges and also of course, the cerebrospinal fluid. It traverses the optic canal and enters the orbit. (Agarwal-2008).

2.2.3 Intraorbital Portion

As a rounded cord, it now runs forwards and slightly laterally and downwards in a somewhat sinuous manner to allow for ocular movements and is continued into the back. (Agarwal-2008).

2.2.4 Intraocular Portion

It then enters the eyeball just above and 3 mm medial to the posterior pole. (Agarwal-2008).

2.2.5 Relations

2.2.5.1 Intracranial Portion

The nerve lies at first above the diaphragm sellae, which covers the pituitary body. Between the two nerves in front of the chiasma is a triangular space in which is a variable portion of the pituitary, covered by the diaphragm sellae. Above the nerve is the anterior perforated substance, the medial root of the olfactory tract and the anterior cerebral artery, which crosses superiorly to reach its medial side. The internal carotid artery is at first below and then lateral. (Agarwal-2008).

2.2.5.2. Intracanalicular Portion

The pia forms a sheath closely adherent to the nerve. The dura constitutes the periosteal lining to the canal and at its orbital end splits to become continuous on the one hand with the periorbita and on the other hand with the dura of the optic nerve. The ophthalmic artery crosses below the nerve in the dural sheath to its lateral side. It leaves the dura at or near the anterior end of the canal. Thus, the internal carotid artery is to some extent tied to the dural sheath by its ophthalmic branch and it is also indirectly attached to the optic nerve by the adherence of the sheaths and by branches to the nerve from the ophthalmic artery. Medial to the optic nerve is the sphenoidal air sinus or a posterior ethmoidal sinus, from which it may be separated by a thin plate of bone only. This provides the explanation of retrobulbar neuritis following a sinus infection. (Agarwal-2008).

2.2.5.3. Intraorbital Portion:

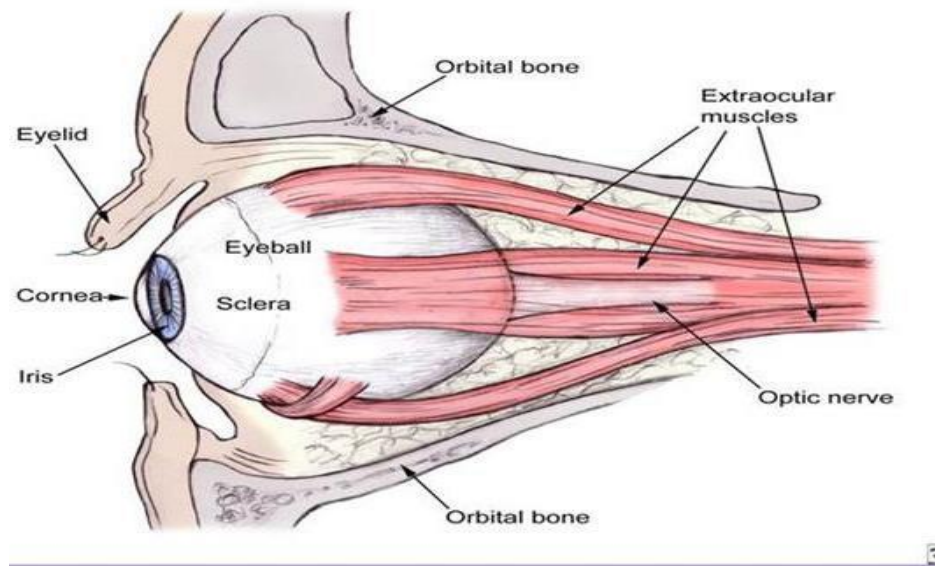


Figure (2-2) Intraorbital part of optic nerve (Agarwal-2008).

At the optic foramen, the nerve is surrounded by the origin of the ocular muscles. The superior and medial rectus is closely adherent to the dural sheath. , It is this connection which gives rise to the pain in Anatomy of the Optic Nerve extreme movements of the globe, so characteristic of retrobulbar neuritis. Between the optic nerve and the lateral rectus are the divisions of the III cranial nerve, nasociliary nerve, sympathetic nerves and the VI cranial nerve. The nasociliary nerve, ophthalmic artery and superior ophthalmic vein cross the nerve superiorly between the nerve and the superior rectus from its lateral to medial side. The ciliary ganglion is lateral to the nerve between the nerve and the lateral rectus. The central retinal artery near the optic foramen, runs forwards in or outside the dural sheath of the nerve. Then it crosses the subarachnoid space to enter the nerve on its under and medial aspect about 12 mm behind the eye. (Agarwal-2008).

2.2.5.4. Intraocular Portion

The intraocular portion passes through the sclera and choroid and finally appears in the eye as the optic disk. The intraocular portion of the optic nerve head has an average diameter of 1.5 mm (Agarwal-2008).

2.2.6 Blood supply of optic nerve

The visual pathway is mainly supplied by pial network of the vessels except the orbital part of optic nerve which also supplied by and axial system derived from the central artery of retina .The pial plexus around different parts of the visual pathway gets contribution from different arteries.

Visual pathway is supplied by: Pial plexus, Calcarian A , Posterior cerebral A and Anterior choroidal A Blood supply of the optic nerve head: The surface layer of the optic disc is supplied by capillaries derived from the retinal arterioles.

The prelaminar region is mainly supplied by centripetal branches of the peripapillary choroid with some contribution from the vessels of lamina cribrosa. The lamina cribrosa is supplied by branches from the posterior ciliary arteries and arterial circle of Zinn.

The retrolaminar part of the optic nerve is supplied by centrifugal branches from central retinal artery and centripetal branches from pial plexus formed by branches from the choroidal arteries, circle of Zinn, central retinal artery and ophthalmic artery. (Agarwal-2008).

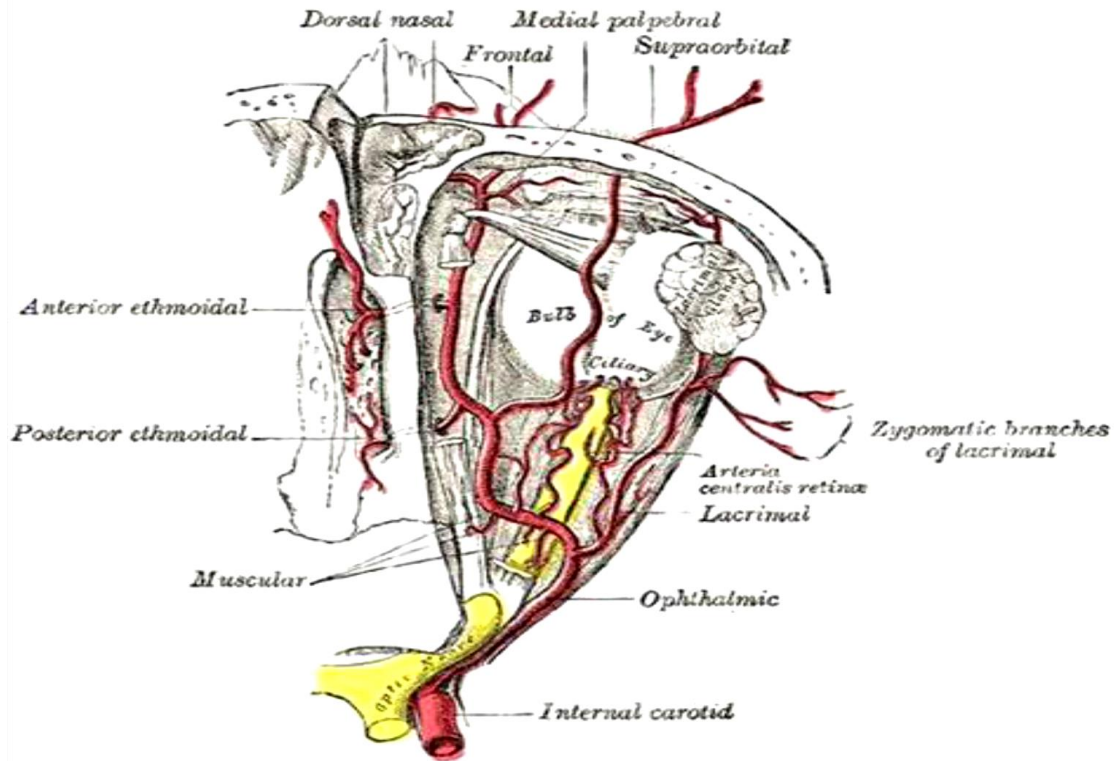


Figure (2-3) Show blood supply of optic nerve (Agarwal-2008).

2.3 Physiology of optic nerve

2.3.1 Process of vision

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. (Montgomery, 1998).

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 control s light response. As the entering light becomes dimmer, the pupil will dilate (get larger). (Montgomery, 1998).

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). (Montgomery, 1998).

2.4 Pathology of optic nerve:

2.4.1. 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, 1998).

2.4.2. Optic neuritis:

Optic neuritis is an inflammation of the optic nerve. It may affect the part of the nerve and disc within the eyeball (papillitis) or the portion behind the eyeball (retrobulbar optic neuritis, causing pain with eye movement). It also includes degeneration or demyelination of the optic nerve. There will be no visible changes in the optic nerve head (disc) unless some optic atrophy has occurred. (Montgomery, 1998).

2.4.3 Papilledema:

Papilledema is edema or swelling of the optic disc (papilla), most commonly due to an increase in intracranial pressure (often from a tumor), malignant hypertension, or thrombosis of the central retinal vein. The condition usually is bilateral, the nerve head is very elevated and swollen, and pupil response typically is normal. (Montgomery, 1998).

Vision is not affected initially (although there is an enlargement of the blind spot), and there is no pain upon eye movement. Secondary optic atrophy and permanent vision loss can occur if the primary cause of the papilledema is left untreated. (Montgomery, 1998).

2.4.4 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, 1998).

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, 1998)

2.5 History of Medical Imaging

Medical imaging began in November 1895 with Wilhelm Conrad Roentgen's discovery of the X-ray. Working with an early cathode ray tube called a Crooke's tube, he noticed that the invisible rays were able to penetrate some solids (like human flesh) better than others (like bone or metal). He confined himself to his basement laboratory in Würzburg, Germany, for six weeks while Frau Roentgen brought him meals. During that time he discovered most of what the world would know about X-rays for the next twenty years. For his efforts he was awarded the first Nobel Prize in 1901. As the X-ray beam became more powerful, patient motion could be visualized and "fluoroscopy" became possible. Fluoroscopy is still in common use today, but it has advanced considerably. Today, with modern image intensifiers, that is no longer necessary. In addition, many of the diseases initially diagnosed by fluoroscopy are now diagnosed by computed tomography. X-ray tomography was introduced in the 1940s, allowing "tomograms" or slices to be obtained through tissues without the over- or under-lying tissue's being seen. Both CT and MRI are tomographic techniques that display the anatomy in slices

rather than through and through projections (like an X-ray) procedures. In the 1950s nuclear medicine entered our armamentarium of diagnostic imaging tests. In these tests, the source of the X-rays is not an X-ray tube but rather radioactive compounds, which typically emit gamma rays as they decay. They are combined with other compounds that are taken up as part of the disease process to study a particular problem. For example, Technetium 99m can be combined with méthylène diphosphonate, which is taken up by bone being invaded by a tumor. So, for example, cancer of the breast or lung, which tends to spread ("metastasize") to the bones can be easily detected by such a nuclear bone scan. Ultrasound was first used clinically in the 1970s. Unlike X-ray and nuclear medicine, ultrasound uses no ionizing radiation - just sound waves. As the sound waves pass through the tissue and are reflected back, tomographic images can be created and tissues can be characterized. For example, a mass found on a mammogram can be further characterized as solid (possibly cancer) or cystic (most likely benign). Ultrasound is also useful for the noninvasive imaging of the abdomen and pelvis, including imaging the fetus during pregnancy. Today ultrasound can be performed by a portable unit no larger than a laptop computer. X-ray is also the basis of mammography, which is a dedicated system that takes high-resolution images of the breasts, looking for breast cancer. Over the years, the X-ray dose of the mammograms has decreased, making the examination safe. Computers really entered the world of medical imaging in the early 1970s with the advent of computed tomography (CT scanning) and then magnetic resonance imaging (MRI). CT was a major advance that first allowed multiple tomographic images (slices) of the brain to be acquired. In CT an X-ray tube rotates around the patient and various detectors pick up the X-rays that are not absorbed, reflected, or refracted as they pass through the body. MRI also evolved during the 1970s, initially on resistive magnets with weak magnetic fields, producing images

with low spatial resolution. Even then, however, it was obvious that the soft tissue discrimination of MRI was superior to that of CT, allowing earlier diagnoses. MR also had the advantage that it did not require ionizing radiation like X-ray based CT. Over the 1980s and 1990s, superconducting magnets became common, initially at 1.5 Tesla and now at 3 Tesla. (Tesla is a measure of magnetic field strength. The earth's magnetic field, for example, is 0.00005 Tesla. Thus a 1.5 T magnet has field strength 30,000 times stronger than that of the earth). [Bradley 2015]

2.6 MRI and CT for orbits:

2.6.1 Orbit Imaging technique:

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

2.6.1.1 Orbit CT technique :

- **Indications:**

Structural diseases of the orbits and orbital contents, trauma and foreign body.

- **Image criteria and Slice thickness:**

Visualization of entire orbits, osseous walls.

Volume of investigation: from 0.5 cm below to 0.5 cm above the orbital cavity. (Henwood, 1999).

- **Patient position:**

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

Lateral scout view is obtained.

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.

Axial scan should cover all orbital region. (Henwood, 1999)

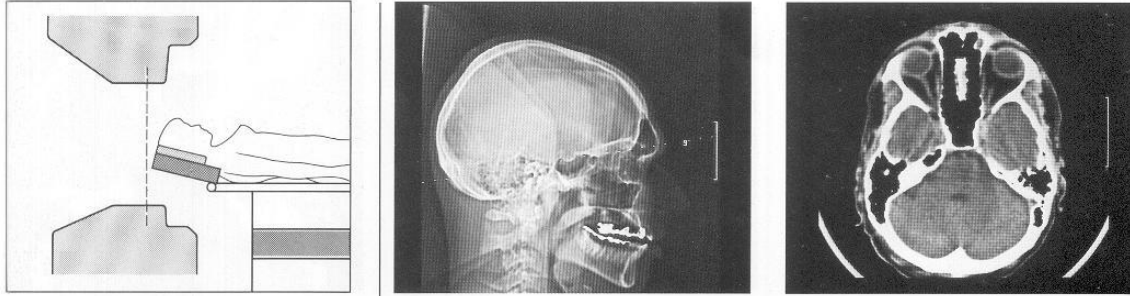


Figure (2-4) Show the Axial C.T scan. (Henwood, 1999).

Slice thickness 2-5 mm. Feed 2-5 mm

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

Coronal scan

Patient's supine, head rest in coronal head holder, with neck hyper extended.

Lateral scout view is obtained.

Coronal scan should cover all orbital region.

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

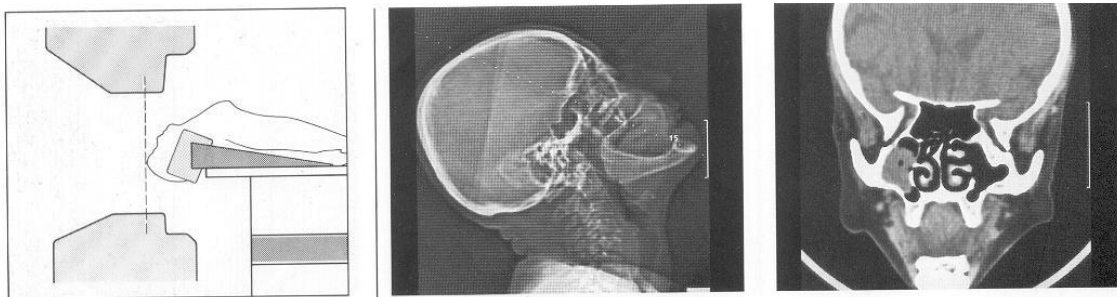


Figure (2-5) shows the C.T coronal scan supine. (Henwood, 1999).

Slice thickness 2-5mm. Feed 2-5mm

- **Coronal prone**

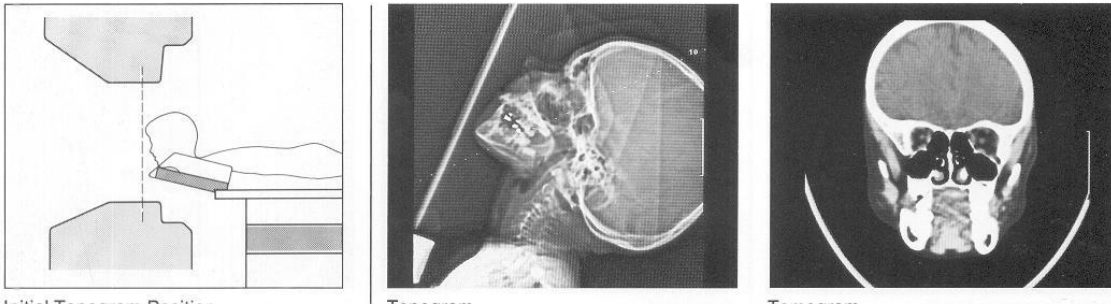


Figure (2-6) shows the C.T coronal scan prone. (Henwood, 1999).

Slice thickness 2-5mm. Feed 2-5mm

2.6.2 Orbit MRI technique :

2.6.2.1 Common indications:

- Proptosis.
- Visual disturbance.
- Evaluation of orbital or ocular mass lesion.

2.6.2.2. 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. (Westbrook, 2008).

2.6.2.3. Patient positioning:

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

LS faces the orbits, i.e. toward the table. The patient assumes a fixed gaze, straight ahead, with the eyes open. This enables the patient to focus and keeps the eyes still. Thereby reducing motion artifact. Any eye make-up is removed prior to the

examination as this causes image artifact and patient discomfort especially if it contains metal. (Westbrook, 2008).

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 center of the coils. Straps and foam pads are used for immobilization. (Westbrook, 2008).

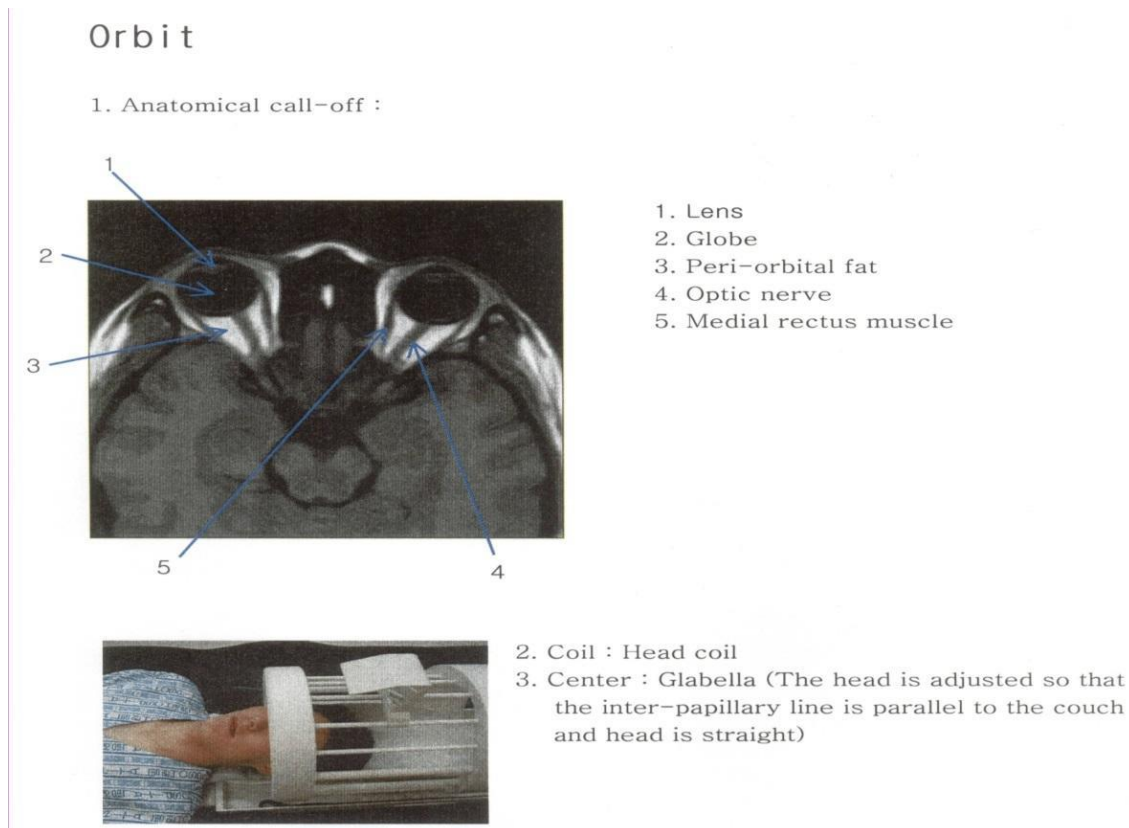


Figure (2-7) shows the orbit anatomy and head coil (Westbrook, 2008).

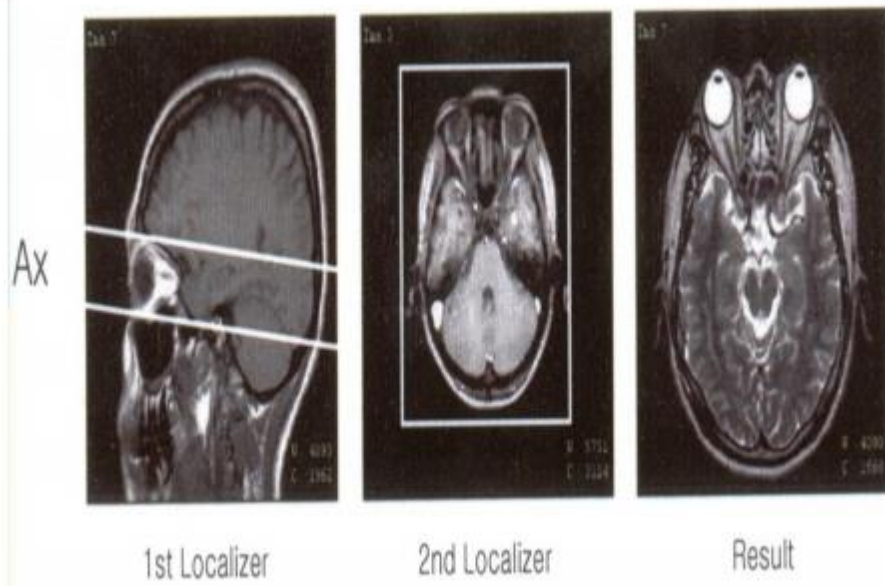
2.6.2.4 Suggested protocol:

Axial SE T1,

Sagittal SE T1,

Coronal SE T1.

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



Fig(2-8) shows the Axial scan (Westbrook, 2008).

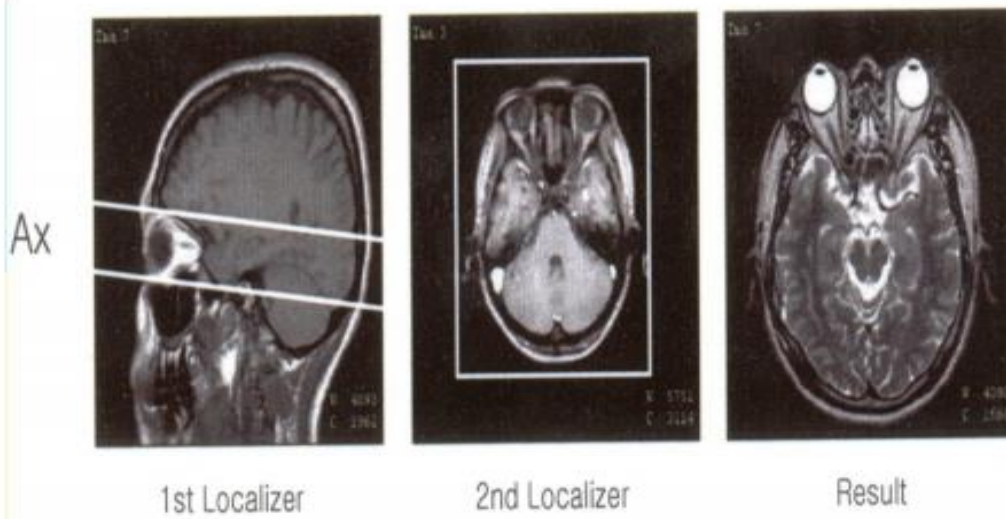


Figure (2-9) Shows the Sagittal scan (Westbrook, 2008).

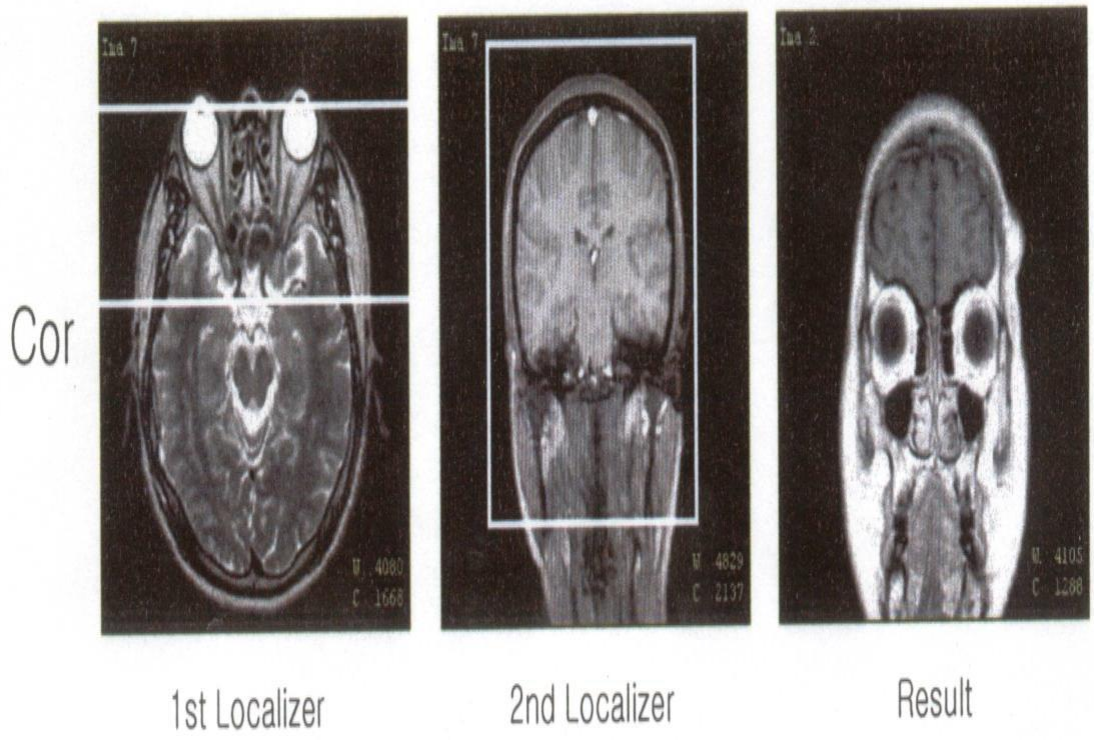


Fig (2-10) shows the Coronal scan (Westbrook, 2008).

2.7 Previous studies:

- **Benevento, *et al* 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 rangeis consistent with published data on the ONSD. However, we are not aware of any published data on the OND.
- **Newcombe, *et al* 2008** Used T2-weighted magnetic resonance imaging of the optic nerve sheath to detect raised intracranial and the 35 results that 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 20mmHg 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.
- **Brex, *et al* 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 17 months (range 3–17 months), using a coronal-oblique fat-saturated –echo fast fluid-attenuated inversion-recovery (sTE fFLAIR) sequence. The mean cross-sectional area of the intraorbital portion of the optic nerves was calculated by a blinded observer from five consecutive 3mm slices from the orbital apex forwards using a semiautomated contouring technique and compared with data from 71 controls. The mean optic nerve area 28 was

7.11 mm² in the affected eye of the patients, 7.11 mm² in the contralateral eye ($P = .13$ compared to the affected eye) and 7.11 mm² in controls ($P = .13$ compared to the affected eyes). There was a significant negative correlation between disease duration and the size of the affected optic nerve ($r = -.11$, $P = .171$). The measurement coefficient of variation was 81%. The sTE fFLAIR 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.

- **Hickman, *et al* 2009** investigate optic neuritis as a model for atrophy in multiple sclerosis (MS) lesion they performed serial magnetic resonance imaging (MRI) on 7 patients with a history of optic neuritis using a fat saturated short-echo fast fluid-attenuated inversion recovery (sTE fFLAIR) sequence. The first study was performed a median of 71.1 months after the onset of optic neuritis and the second 7 year later. Using a computer-assisted contouring technique, a blinded observer calculated the mean area of the intra-orbital optic nerves. The mean area of affected optic nerves decreased over 7 year by .11 mm² from 7.17 to 7.11 mm² ($p = .17$). Poor visual acuity and decreased visual-evoked potential (VEP) amplitude were associated with atrophy. These findings suggest that atrophy is a feature of focal demyelinating lesions, it may evolve over several years, and may have functional significance. Optic neuritis provides a model to study the effect of inflammatory demyelination the ability to accurately measure visual function and to visualize and measure the optic nerves using magnetic resonance imaging.

➤ **Newman , *et al* 2009** evaluate the utility of measuring the optic nerve sheath diameter in children with shunted hydrocephalus, suspected of having raised intracranial pressure used 13 children with shunted hydrocephalus were examined, six had well controlled ICP, 71 however manifested symptoms suggestive of intracranial hypertension. A clinical history was taken from all patients and their parents or carers. The shunt valve was examined clinically, and signs of raised intracranial pressure were sought. Ultrasound examination was performed in both eyes to measure the optic nerve sheath diameters 3mm behind the globe. These measurements were compared with control data obtained from 7137 children who attended the radiology department for unrelated renal ultrasound examination. Control data are the upper limit of normal for optic nerve sheath diameter is 8.1mm (measured 3mm behind the globe) in patients over 7 year of age, and 8.1mm in children less than 7 year of age. Those patients with functioning ventriculoperitoneal shunts had a mean optic nerve sheath diameter of 11.1(SD 1.1) mm; those with raised intracranial pressure had a mean optic nerve sheath diameter of 10.1(1.0) mm ($p < .0007$). These results confirm that optic nerve sheath diameters in excess of the control data are strongly suggestive of raised intracranial pressure. 138.

Chapter Three
Materials and Methods

Chapter Three

Materials and Methods

3.1 Materials:

3.1.1 Study Population:

The total samples of patients were **50**, their ages between 18 – 80 years old all were under went MRI orbits. The study has been carried out during the period from 1st January to 15th February **2018** at the modern diagnostic center Khartoum state, the data was analyzed using Excel program and SPSS version 20.

3.1.2 Machine

Toshiba 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 μ se c. (0 - 40 mT/m) Slew rate 200 T/m/s Max. Gradient current 625 A Max voltage (across Gradient Coil) 2000 V Gradient Coil AS 092[Toshiba products corporation .inc]

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 pads are used for immobilization.

3.2.1 Technique

1. Axial SE T1
2. Coronal SE T1
3. Sagittal SE T1

Sagittal oblique T2 Tr 5000 Te 105 for the length.

Coronal T2 Tr 5000 Te 105 for the widths.

Small surface coil for globe and orbit, quadrature head coil for orbital apex, Immobilization straps and foam pads.

3.2.2 Image measurement

By measuring 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).

3.2.3 Statistic method

All patient demographic data and measurement parameters were analyzed Using Excel 2013 and SPSS version 20 method for data analysis. The Necessary statistical measures were applied to assess the results.

3.2.4 Ethical Considerations

- Written ethical clearance and approval for conducting this research was Obtained from an administration of Dar Alelaj Specialized Hospital.
- Study data/information will only be used for the research purposes.

3.2.5 Common indications:

1. Proptosis.
2. Visual disturbance.
3. Evaluation of orbital or ocular mass lesion

Chapter Four

Results

Chapter four

4.1 Results

Table (4-1) classification according to gender.

Gender	Frequency	Percent
male	23	46.0
female	27	54.0
Total	50	100.0

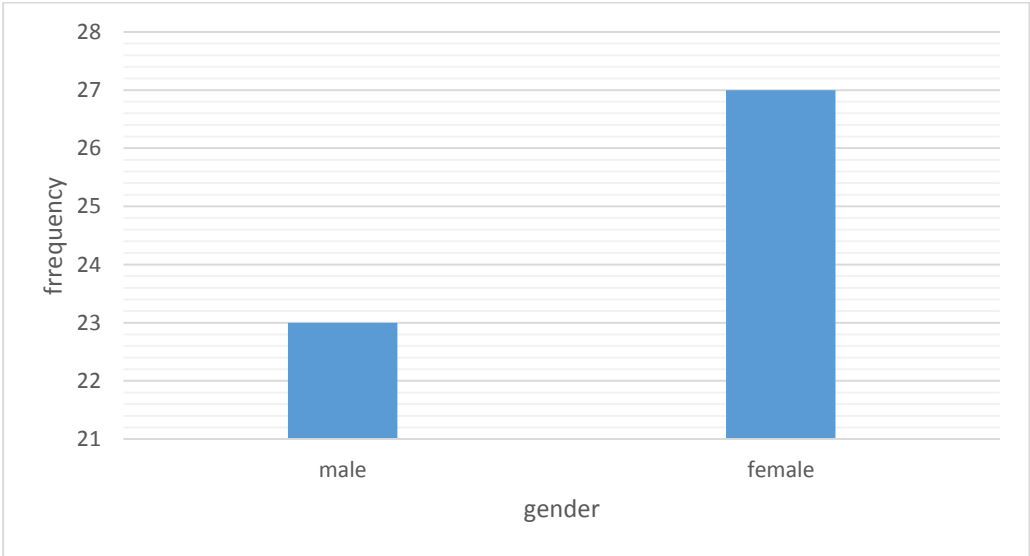


Figure (4.1) gender distribution.

Table (4-2) classification according to age.

Age groups	Frequency	Percent
15-27	16	32.0
27.3-39.3	11	22.0
39.6-51.6	8	16.0
51.9-64	5	10.0
64.2-76.2	8	16.0
76.5-89	2	4.0
Total	50	100.0

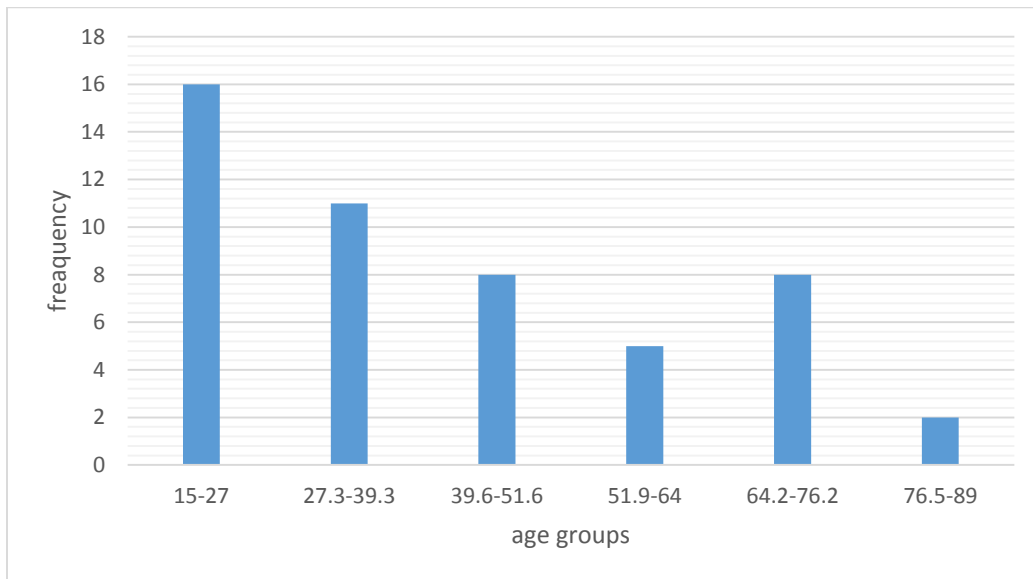


Figure (4-2) age distribution.

Table (4.3) group statistics

Group Statistics	Gender	N	Mean	Std. Deviation
Right length	Male	23	4.8539	0.42972
	female	27	4.5078	0.35985
Left length	Male	23	4.9200	0.40955
	female	27	4.5622	0.37936
Right width	Male	23	0.4322	0.04738
	female	27	0.4185	0.05559
Left width	Male	23	0.4448	0.05265
	female	27	0.4170	0.05986

Table (4-4) descriptive statistics

	Min	Max	Mean	Std. D
Right length	3.80	5.80	4.6670	0.42660
Left length	3.91	5.85	4.7268	0.42908
Right width	0.33	0.54	0.4248	0.05191
Left width	0.28	0.56	0.4298	0.05780
Age	15.0	89.0	41.780	19.6524
weight	55.0	96.0	73.700	11.9783

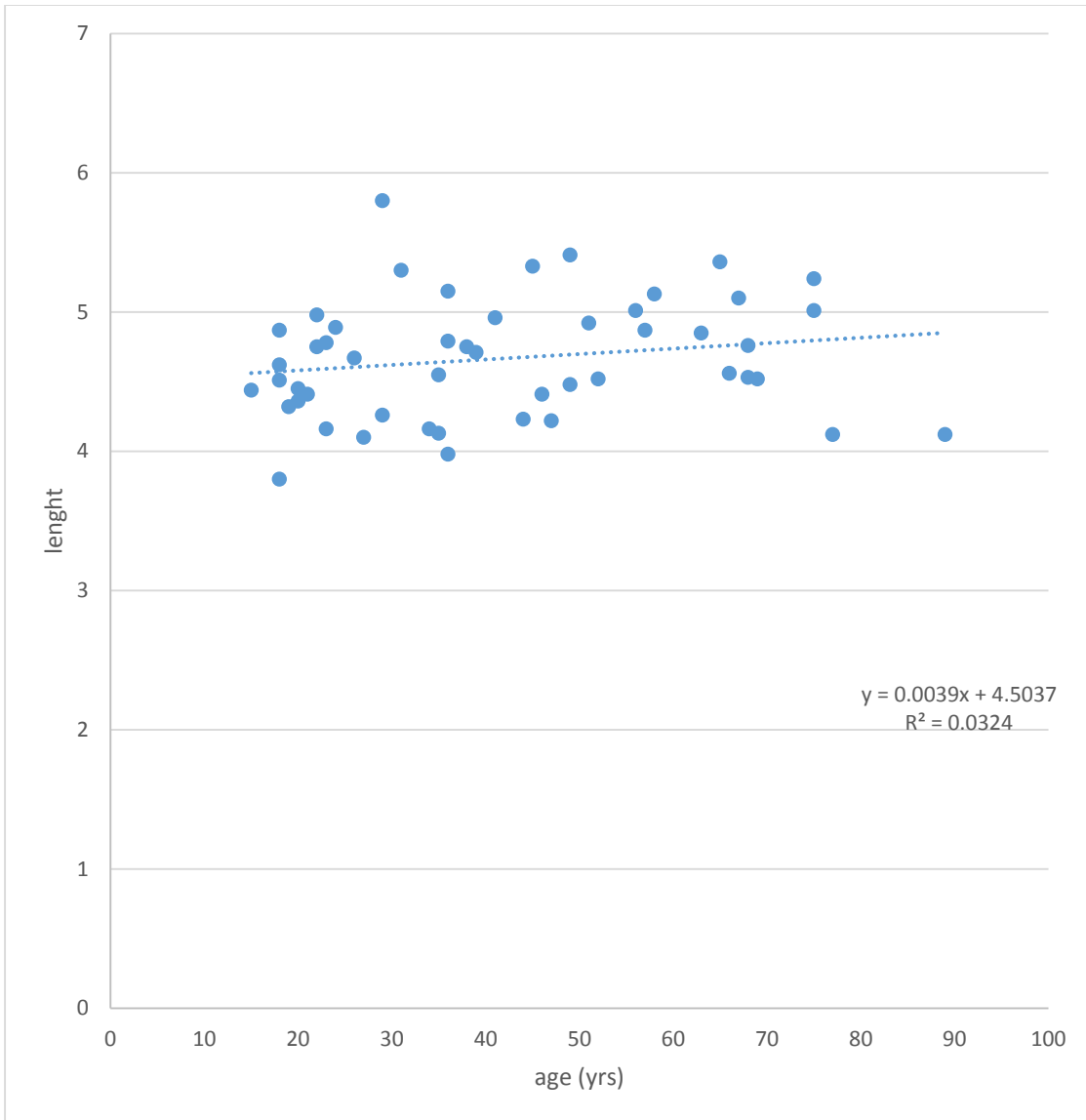


Figure (4-3) correlation between the age and the length of optic nerve

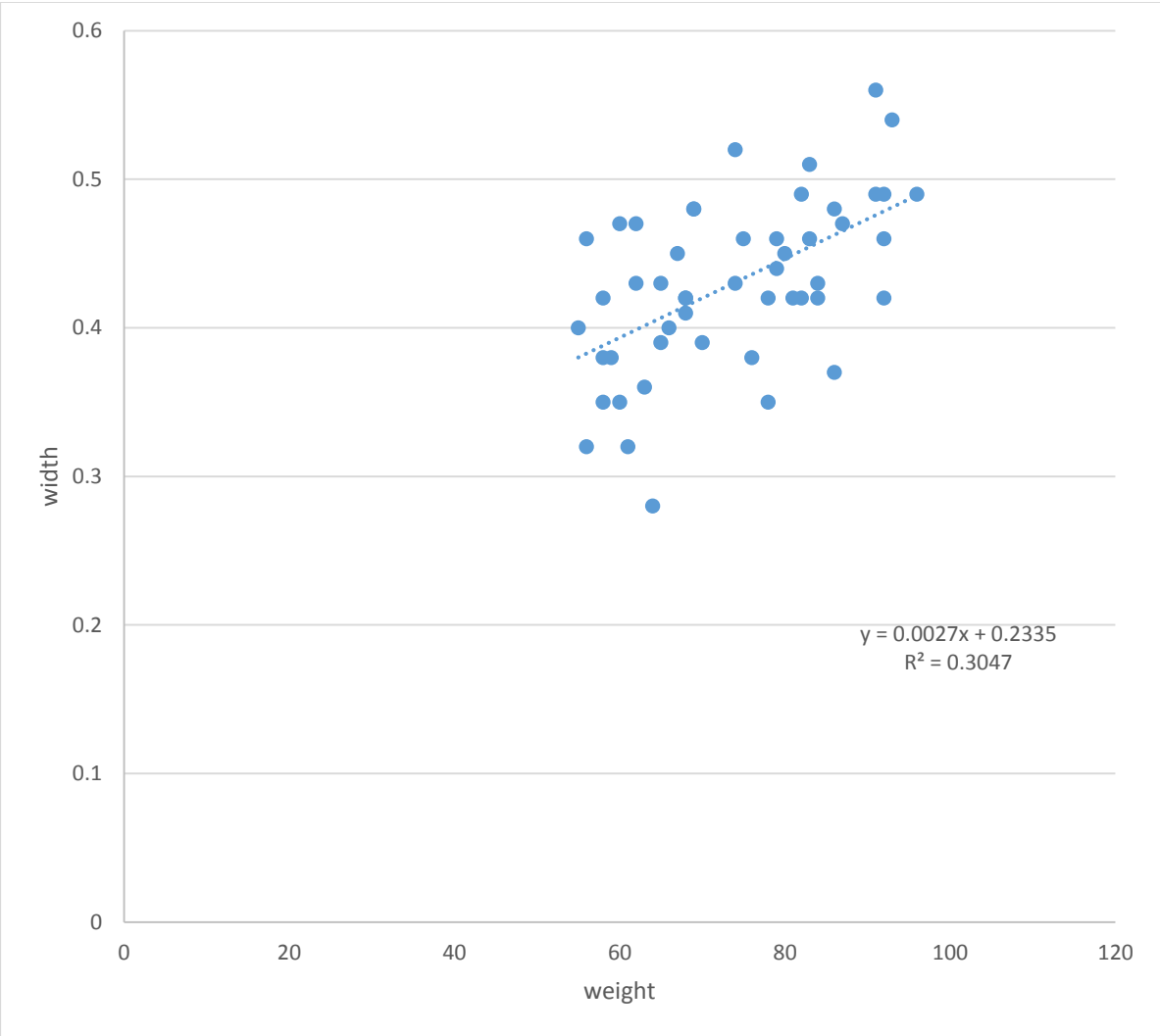


Figure (4-4) correlation between the weight and the width of optic nerve

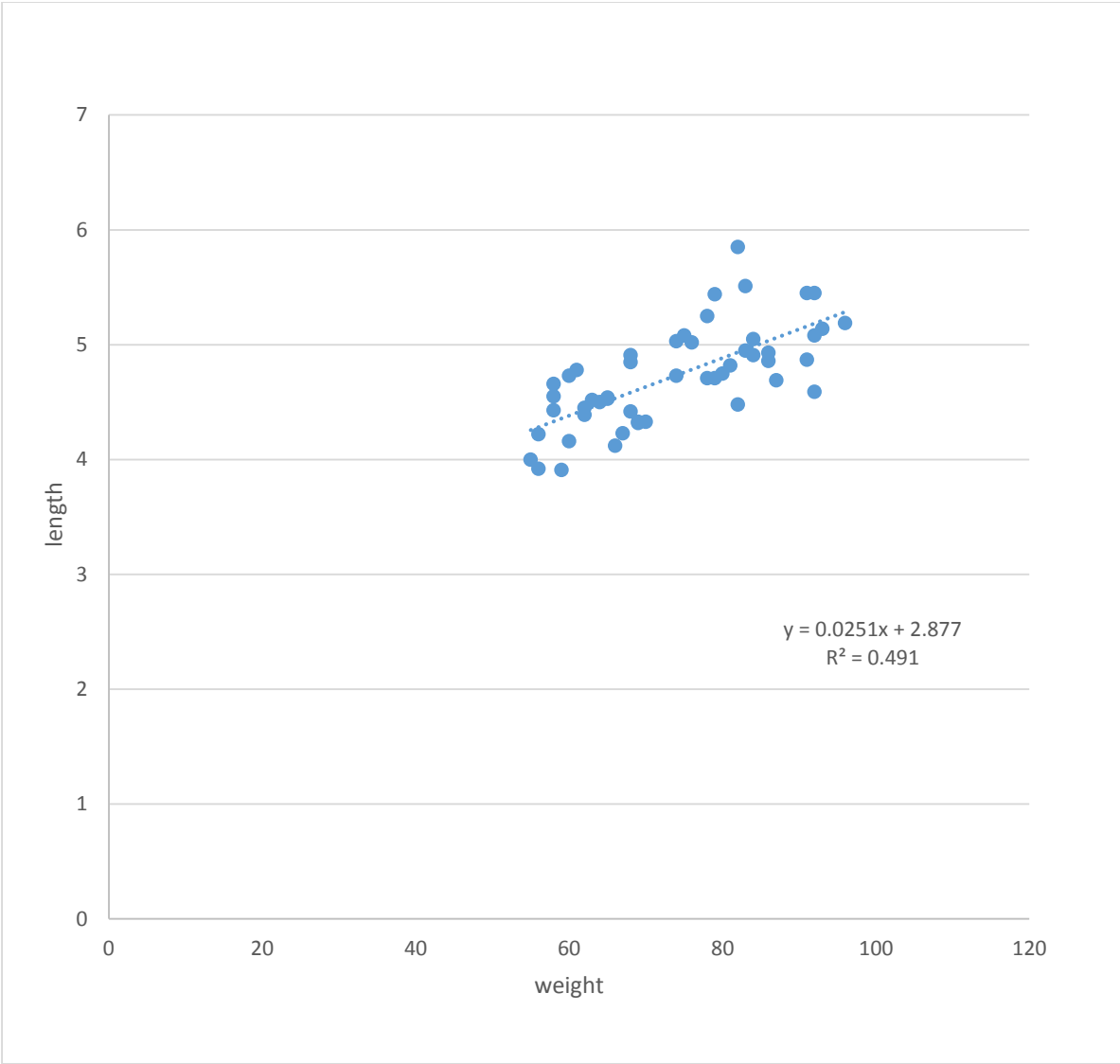


Figure (4-5) correlation between weight and length of optic nerve

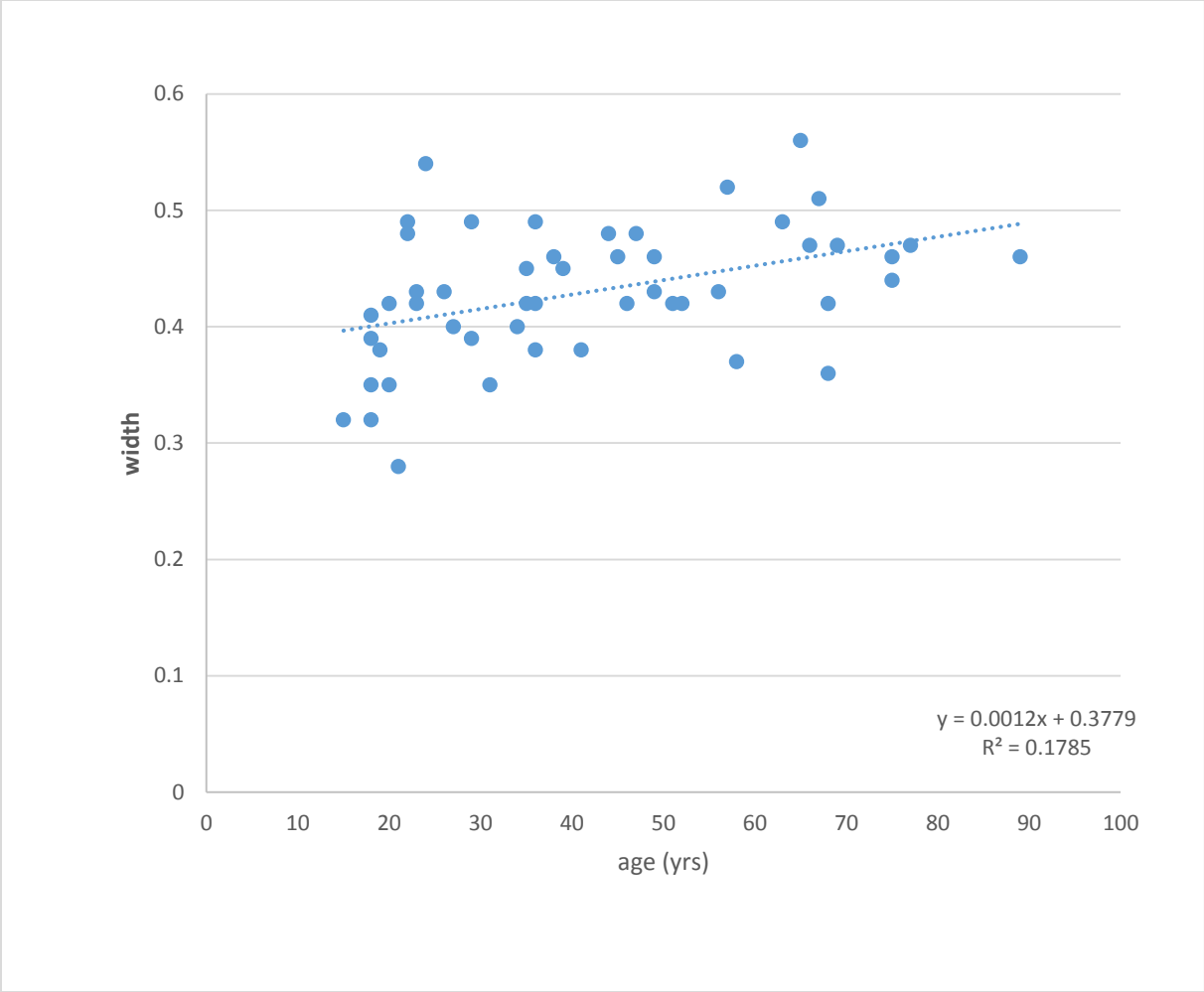


Figure (4-6) Correlation between age and width of optic nerve.

Chapter five
Discussion, Conclusion and
Recommendations

Chapter Five

Discussion, Conclusion and Recommendations

5.1 Discussion

Number of 50 patients MRI orbit and brain was performed for Sudanese patient there ages between 20–80 years old, were 23 males and 27 females.

The result after data analysis was found the mean of optic nerve length [4.6670±0.42660] cm in the right eye, [4.7268±0.42908] cm in the left one, and the mean of optic nerve width [0.4248±0.05191] cm in the right eye, [0.4298±0.05780] cm in the left eye. with minimum length [3.80 cm] in right eye , [3.91cm] in the left one , and maximum length [5.80 cm] in right eye , [5.85 cm] in the left one . with minimum width [0.33 cm] in right eye , [0.28 cm] in the left one, and maximum width [0.54 cm] in right eye, [0.56 cm] in the left one .

The result of this studies (minimum length [3.80cm] [3.85 cm] in both eyes, and maximum length [5.85 cm] and [3.80cm] in both eyes) similar to result obtained by MRI in (Benvento, *el al* 2001 studies optic nerve measurements in normal human eyes by MRI (minimum length {4.00cm} and maximum length {6.00cm}).

From these results there is direct relationship between the width of optic nerve and age, the width increase by 0.01 cm to each year.

Also there is direct relationship between the optic nerve length and the weight, the length increase by 0.003 cm to each kg of weight.

The mean optic nerve length for male [4.886±0.4626] cm, is slightly higher than mean optic nerve length for female [4.5350±0.36961] cm.

The mean optic nerve width for male [.4055±.08804] cm, is slightly higher than

mean optic nerve width for female [$.3890 \pm .11078$] cm.

5.2 Conclusion:

- Using MRI This study was conducted to find out the mean optic nerve length and width in Sudanese population.
- The overall mean of optic nerve length in 50 Sudanese patient was [$4.7105 \pm .43099$] cm, and mean of optic nerve width [0.3972 ± 0.09941] cm.
- The optic nerve (length & width) slightly higher in males.

5.3 Recommendations:

- The minimum length of optic nerve must not exceed [3.8cm], and maximum length [5.85 cm].
- The minimum width of optic nerve must not exceed [.28cm], and maximum width [.56 cm].
- Is always important to know the reference value for optic nerve diameters in Sudanese population, to state the pathology and abnormality easily.
- The age and gender are important parameters that affect the optic nerve length and width.

I recommend using a larger sample size, from difference state of the country.

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Appendixes

Appendix (1)

Data Collection Sheet

<i>NO.</i>	<i>Age year</i>	<i>Weight kg</i>	<i>GENDER F/M</i>	<i>Axial length mm</i>		<i>Coronal width cm</i>	
				RT	LT	RT	LT
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

Appendix (2)

