Sudan University of Sciences and Technology

SCIENCE COLLEGE

Science Laboratory Physics Section

Graduation project

For:

LASER APPLICATIONS ON EYE TREATMENT

Prepared by:

Mariam Omer Edress

Nuha Abdallah Khalid

Aread Abakar Suliaman

Hind Alrasheed Mohammed

Under Supervision of:

PROF.D. Mohammed Osman

September 2016

الآية

قَالَ تَعَالَىٰ:

﴿ وَٱللَّهُ أَخۡرَجَكُم مِّنۢ بُطُونِ أُمَّهَٰتِكُمۡ لَا تَعۡلَمُونَ شَيۡـٔٗا وَجَعَلَ
لَكُمُ ٱلسَّمۡعَ وَٱلۡأَبۡصَٰرَ وَٱلۡأَفۡـِٔدَةَ لَعَلَّكُمۡ تَشۡكُرُونَ ٧٨ ﴾

صدق الله العظيم .

سورة النحل الآية (78)

الإهـــداء

بودي لو أهمس لأولئك المنشغلة أرواحهم بتجميل أكواني

عائلتي:

أمي ... أبي

لأولئك الذين يصنعون الدروب ويجعلون المشي فيها ممكناً..

صديقاتي

ولكم أنتم بالذات ..

إخوتي وأخواتي

الشكر والتقدير

إلهي لا يطيب الليل إلا بشكرك..... ولا يطيب النهار إلا بطاعتك ..... ولا تطيب اللحظات إلا بذكرك .... ولاتطيب الاخرة إلا بعفوك ... ولا تطيب الجنة إلا برؤيتك الله جلاله...

إلى من بلغ الرسالة وأدى الأمانة ونصح الأمة ... إلى نبي الرحمة ونور العالمين .. إلى قدوتنا ومعلمنا وقائد أمتنا سيدنا محمد صلى الله عليه وسلم

إلى كل من أضاء بعلمه عقل غيره أو هدى بالجواب الصحيح حيرة سائليه فأظهر بسماحته تواضع العلماء .. وبرحابته سماحة العارفين ..

إلى ***البروفيسور محمد عثمان***

الذي سهر الليالي لينير دروبنا بالعلم

إلى أستاذي سفيان شرف الدين...

Abstract

Lasers are widely used in Sudan. They have almost no side effects, but they require high accuracy. High exposure or directing of laser to the wrong part of the eye could cause damage.

In this research were studied the treatment of the diseases Glaucoma, vision correction ,Myopia) has been done using lasers (Ar+ & ND: YAG lasers).

المستخلص

استخدمت أشعة الليزر في نطاق واسع في السودان وهي تخلو تماما من الاثار الجانبية ولكنها تحتاج الي دقة في التوجيه والتعرض، حيث اذا وجه في الاتجاه الخاطئ في العين سيتسبب في ضرر جسيم .

و في هذا البحث تمت دراسة أمراض (المياه البيضاء و السوداء في العين، تصحيح النظر، وقصر النظر) باستخدام ليزرات (الأرجون – النيوديوم : ياج) .

Table of contents

Chapter Two

Chapter Three

Chapter Four

CHAPTER ONE

INTRODUCTION

1.1 laser

A laser is a device that emits light through a process of optical amplification based on the stimulated emission of electromagnetic radiation. The term "laser" originated as an acronym for **"light amplification by stimulated emission of radiation"**. [1][2] The first laser was built in 1960 by Theodore H. Maiman at Hughes Research Laboratories, based on theoretical work by Charles Hard Townes and Arthur Leonard Schawlow. A laser differs from other sources of light in that it emits light *coherently*. Spatial coherence allows a laser to be focused to a tight spot, enabling applications such as laser cutting and lithography. Spatial coherence also allows a laser beam to stay narrow over great distances (collimation), enabling applications such as laser pointers. Lasers can also have high temporal coherence, which allows them to emit light with a very narrow spectrum, i.e., they can emit a single color of light. Temporal coherence can be used to produce pulses of light as short as a femtosecond.

Among their many applications, lasers are used in optical disk drives, laser printers, and barcode scanners; DNA sequencing instruments, fiber-optic and free-space optical communication; laser surgery and skin treatments; cutting and welding materials; military and law enforcement devices for marking targets and measuring range and speed; and laser lighting displays in entertainment.

1.1.1 Fundamentals

1. Lasers are distinguished from other light sources by their coherence. Spatial coherence is typically expressed through the output being a narrow beam, which is diffraction-limited. Laser beams can be focused to very tiny spots, achieving a very high irradiance, or they can have very low divergence in order to concentrate their power at a great distance.

Temporal (or longitudinal) coherence implies a polarized wave at a single frequency whose phase is correlated over a relatively great distance (the coherence length) along the beam. [3] A beam produced by a thermal or other incoherent light source has an instantaneous amplitude and phase that vary randomly with respect to time and position, thus having a short coherence length.

Lasers are characterized according to their wavelength in a vacuum. Most "single wavelength" lasers actually produce radiation in several *modes* having slightly differing frequencies (wavelengths), often not in a single polarization. Although temporal coherence implies monochromaticity, there are lasers that emit a broad spectrum of light or emit different wavelengths of light simultaneously. There are some lasers that are not single spatial mode and consequently have light beams that diverge more than is required by the diffraction limit. However, all such devices are classified as "lasers" based on their method of producing light, i.e., stimulated emission. Lasers are employed in applications where light of the required spatial or temporal coherence could not be produced using simpler technologies.

1.1.2 Design

A laser consists of a gain medium, a mechanism to energize it, and something to provide optical feedback. [4] The gain medium is a material with properties that allow it to amplify light by way of stimulated emission. Light of a specific wavelength that passes through the gain medium is amplified (increases in power).

For the gain medium to amplify light, it needs to be supplied with energy in a process called pumping. The energy is typically supplied as an electric current or as light at a different wavelength. Pump light may be provided by a flash lamp or by another laser.

The most common type of laser uses feedback from an optical cavity—a pair of mirrors on either end of the gain medium. Light bounces back and forth between the mirrors, passing through the gain medium and being amplified each time. Typically one of the two mirrors, the output coupler, is partially transparent. Some of the light escapes through this mirror. Depending on the design of the cavity (whether the mirrors are flat or curved), the light coming out of the laser may spread out or form a narrow beam. In analogy to electronic oscillators, this device is sometimes called a *laser oscillator*.

Most practical lasers contain additional elements that affect properties of the emitted light, such as the polarization, wavelength, and shape of the beam.

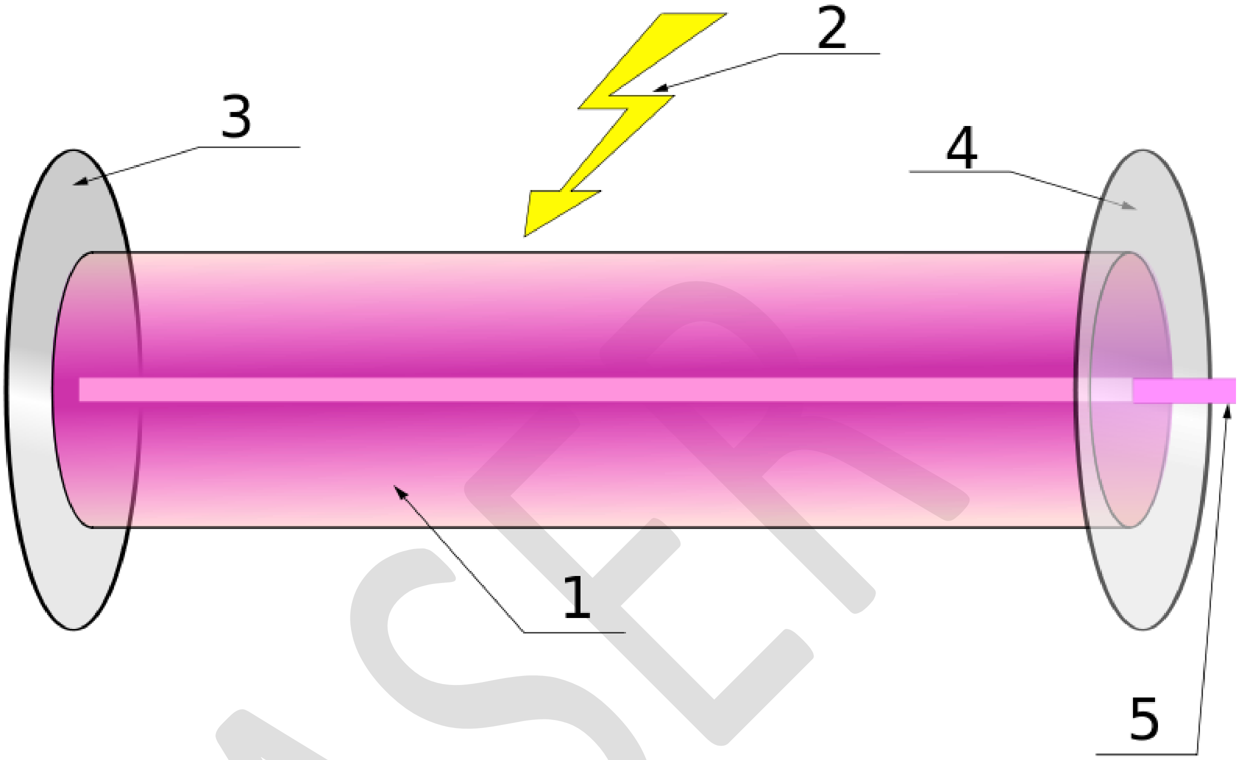

Figure (1.1): Components of a typical laser:

1. Gain medium

2. Laser pumping energy

3. High reflector

4. Output coupler

5. Laser beam

1.1.3 Laser physics

Electrons and how they interact with electromagnetic fields are important in our understanding of chemistry and physics.

Stimulated emission

In the classical view, the energy of an electron orbiting an atomic nucleus is larger for orbits further from the nucleus of an atom. However, quantum mechanical effects force electrons to take on discrete positions in orbitals. Thus, electrons are found in specific energy levels of an atom, two of which are shown below:

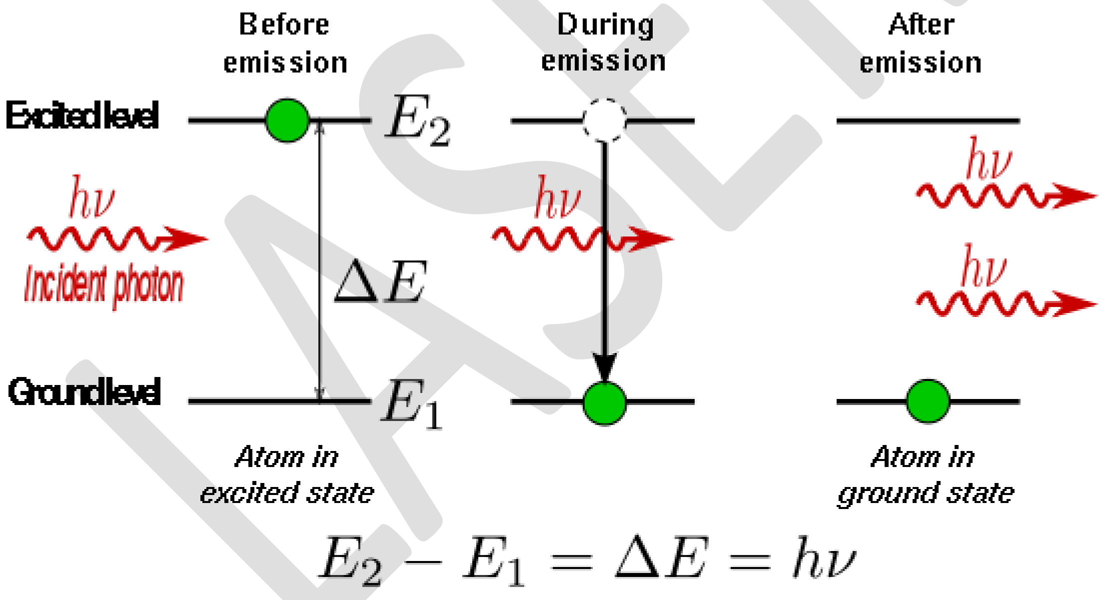

Figure (1.2): Stimulated emission

When an electron absorbs energy either from light (photons) or heat (phonons), it receives that incident quantum of energy. But transitions are only allowed in between discrete energy levels such as the two shown above. This leads to emission lines and absorption lines.

When an electron is excited from a lower to a higher energy level, it will not stay that way forever. An electron in an excited state may decay to a lower energy state which is not occupied, according to a particular time constant characterizing that transition. When such an electron decays without external influence, emitting a photon, that is called "spontaneous emission". The phase associated with the photon that is emitted is random. A material with many atoms in such an excited state may thus result in radiation which is very spectrally limited (centered around one wavelength of light), but the individual photons would have no common phase relationship and would emanate in random directions. This is the mechanism of fluorescence and thermal emission.

An external electromagnetic field at a frequency associated with a transition can affect the quantum mechanical state of the atom. As the electron in the atom makes a transition between two stationary states (neither of which shows a dipole field), it enters a transition state which does have a dipole field, and which acts like a small electric dipole, and this dipole oscillates at a characteristic frequency. In response to the external electric field at this frequency, the probability of the atom entering this transition state is greatly increased. Thus, the rate of transitions between two stationary states is enhanced beyond that due to spontaneous emission. Such a transition to the higher state is called absorption, and it destroys an incident photon (the photon's energy goes into powering the increased energy of the higher state). A transition from the higher to a lower energy state, however, produces an additional photon; this is the process of stimulated emission.

1.1.4 Types and operating principles

1.1.4.1 Gas lasers

Following the invention of the HeNe gas laser, many other gas discharges have been found to amplify light coherently. Gas lasers using many different gases have been built and used for many purposes. The helium–neon laser (HeNe) is able to operate at a number of different wavelengths, however the vast majority are engineered to lase at 633 nm; these relatively low cost but highly coherent lasers are extremely common in optical research and educational laboratories. Commercial carbon dioxide (CO_2) lasers can emit many hundreds of watts in a single spatial mode which can be concentrated into a tiny spot. This emission is in the thermal infrared at 10.6 µm; such lasers are regularly used in industry for cutting and welding. The efficiency of a CO_2 laser is unusually high: over 30%.[5]Argon-ion lasers can operate at a number of lasing transitions between 351 and 528.7 nm. Depending on the optical design one or more of these transitions can be lasing simultaneously; the most commonly used lines are 458 nm, 488 nm and 514.5 nm. A nitrogen transverse electrical discharge in gas at atmospheric pressure (TEA) laser is an inexpensive gas laser, often home-built by hobbyists, which produces rather incoherent UV light at 337.1 nm. [6] Metal ion lasers are gas lasers that generate deep ultraviolet wavelengths. Helium-silver (HeAg) 224 nm and neon-copper (NeCu) 248 nm are two examples. Like all low-pressure gas lasers, the gain media of these lasers have quite narrow oscillation linewidths, less than 3 GHz (0.5 picometers), [7] making them candidates for use in fluorescence suppressed Raman spectroscopy.

1.1.4.2 Chemical lasers

Chemical lasers are powered by a chemical reaction permitting a large amount of energy to be released quickly. Such very high power lasers are especially of interest to the military, however continuous wave chemical lasers at very high power levels, fed by streams of gasses, have been developed and have some industrial applications. As examples, in the hydrogen fluoride laser (2700–2900 nm) and the deuterium fluoride laser (3800 nm) the reaction is the combination of hydrogen or deuterium gas with combustion products of ethylene in nitrogen trifluoride.

1.1.4.3 Excimer lasers

Excimer lasers are a special sort of gas laser powered by an electric discharge in which the lasing medium is an excimer, or more precisely an exciplex in existing designs. These are molecules which can only exist with one atom in an excited electronic state. Once the molecule transfers its excitation energy to a photon, therefore, its atoms are no longer bound to each other and the molecule disintegrates. This drastically reduces the population of the lower energy state thus greatly facilitating a population inversion. Excimers currently used are all noble gas compounds; noble gasses are chemically inert and can only form compounds while in an excited state. Excimer lasers typically operate at ultraviolet wavelengths with major applications including semiconductor photolithography and LASIK eye surgery. Commonly used excimer molecules include ArF (emission at 193 nm), KrCl (222 nm), KrF (248 nm), XeCl (308 nm), and XeF (351 nm). [8] The molecular fluorine laser, emitting at 157 nm in the vacuum ultraviolet is sometimes referred to as an excimer laser, however this appears to be a misnomer inasmuch as F_2 is a stable compound.

1.1.4.4 Solid-state lasers

A 50 W FASOR, based on a Nd:YAG laser, used at the Starfire Optical Range.

Solid-state lasers use a crystalline or glass rod which is "doped" with ions that provide the required energy states. For example, the first working laser was a ruby laser, made from ruby (chromium-doped corundum). The population inversion is actually maintained in the dopant. These materials are pumped optically using a shorter wavelength than the lasing wavelength, often from a flashtube or from another laser. The usage of the term "solid-state" in laser physics is narrower than in typical use. Semiconductor lasers (laser diodes) are typically *not* referred to as solid-state lasers.

Neodymium is a common dopant in various solid-state laser crystals, including yttrium orthovanadate ($Nd:YVO_4$), yttrium lithium fluoride (Nd:YLF) and yttrium aluminium garnet (Nd:YAG). All these lasers can produce high powers in the infrared spectrum at 1064 nm. They are used for cutting, welding and marking of metals and other materials, and also in spectroscopy and for pumping dye lasers. These lasers are also commonly frequency doubled, tripled or quadrupled to produce 532 nm (green, visible), 355 nm and 266 nm (UV) beams, respectively. Frequency-doubled diode-pumped solid-state (DPSS) lasers are used to make bright green laser pointers.

Ytterbium, holmium, thulium, and erbium are other common "dopants" in solid-state lasers. Ytterbium is used in crystals such as Yb:YAG, Yb:KGW, Yb:KYW, Yb:SYS, Yb:BOYS, $Yb:CaF_2$, typically operating around 1020–1050 nm. They are potentially very efficient and high powered due to a small quantum defect. Extremely high powers in ultrashort pulses can be achieved with Yb:YAG. Holmium-doped YAG crystals emit at 2097 nm and form an efficient laser operating at infrared wavelengths strongly absorbed by water-bearing tissues. The Ho-YAG is usually operated in a pulsed mode, and passed through optical fiber surgical devices to resurface joints, remove rot from teeth, vaporize cancers, and pulverize kidney and gall stones.

Titanium-doped sapphire (Ti:sapphire) produces a highly tunable infrared laser, commonly used for spectroscopy. It is also notable for use as a mode-locked laser producing ultrashort pulses of extremely high peak power.

Thermal limitations in solid-state lasers arise from unconverted pump power that heats the medium. This heat, when coupled with a high thermo-optic coefficient (dn/dT) can cause thermal lensing and reduce the quantum efficiency. Diode-pumped thin disk lasers overcome these issues by having a gain medium that is much thinner than the diameter of the pump beam. This allows for a more uniform temperature in the material. Thin disk lasers have been shown to produce beams of up to one kilowatt. [9]

1.1.4.5 Dye lasers

Dye lasers use an organic dye as the gain medium. The wide gain spectrum of available dyes, or mixtures of dyes, allows these lasers to be highly tunable, or to produce very short-duration pulses (on the order of a few femtoseconds). Although these tunable lasers are mainly known in their liquid form, researchers have also demonstrated narrow-linewidth tunable emission in dispersive oscillator configurations incorporating solid-state dye gain media. [10] In their most prevalent form these solid state dye lasers use dye-doped polymers as laser media.

1.1.5 Applications

Lasers range in size from microscopic diode lasers (top) with numerous applications, to football field sized neodymium glass lasers (bottom) used for inertial confinement fusion, nuclear weapons research and other high energy density physics experiments.
Main article: List of applications for lasers

When lasers were invented in 1960, they were called "a solution looking for a problem". [11] Since then, they have become ubiquitous, finding utility in thousands of highly varied applications in every section of modern society, including consumer electronics, information technology, science, medicine, industry, law enforcement, entertainment, and the military. Fiber-optic communication using lasers is a key technology in modern communications, allowing services such as the Internet.

The first use of lasers in the daily lives of the general population was the supermarket barcode scanner, introduced in 1974. The laserdisc player, introduced in 1978, was the first successful consumer product to include a laser but the compact disc player was the first laser-equipped device to become common, beginning in 1982 followed shortly by laser printers.

1.1.5.1 Some other applications:

- Medicine: Bloodless surgery, laser healing, surgical treatment, kidney stone treatment, eye treatment, dentistry.

- Industry: Cutting, welding, material heat treatment, marking parts, non-contact measurement of parts.
- Military: Marking targets, guiding munitions, missile defence, electro-optical countermeasures (EOCM), alternative to radar, blinding troops.

  Law enforcement: used for latent fingerprint detection in the forensic identification field. [12 ,13]

- Research: Spectroscopy, laser ablation, laser annealing, laser scattering, laser interferometry, lidar, laser capture microdissection, fluorescence microscopy, metrology.
- Product development/commercial: laser printers, optical discs (e.g. CDs and the like), barcode scanners, thermometers, laser pointers, holograms, bubblegrams.
- Laser lighting displays: Laser light shows.
- Cosmetic skin treatments: acne treatment, cellulite and striae reduction, and hair removal.

1.1.6 Safety

Figure (1.3): Laser safety

Left: European laser warning symbol required for Class 2 lasers and higher.

Right: US laser warning label, in this case for a Class 3B laser

Even the first laser was recognized as being potentially dangerous. Theodore Maiman characterized the first laser as having a power of one "Gillette" as it could burn through one Gillette razor blade. Today, it is accepted that even low-power lasers with only a few milliwatts of output power can be hazardous to human eyesight when the beam hits the eye directly or after reflection from a shiny surface. At wavelengths which the cornea and the lens can focus well, the coherence and low divergence of laser light means that it can be focused by the eye into an extremely small spot on the retina, resulting in localized burning and permanent damage in seconds or even less time.

1.1.7 Classes of Lasers

- Class 1 is inherently safe, usually because the light is contained in an enclosure, for example in CD players.

- Class 2 is safe during normal use; the blink reflex of the eye will prevent damage. Usually up to 1 mW power, for example laser pointers.
- Class 3R (formerly IIIa) lasers are usually up to 5 mW and involve a small risk of eye damage within the time of the blink reflex. Staring into such a beam for several seconds is likely to cause damage to a spot on the retina.
- Class 3B can cause immediate eye damage upon exposure.

- Class 4 lasers can burn skin, and in some cases, even scattered light can cause eye and/or skin damage. Many industrial and scientific lasers are in this class.

The indicated powers are for visible-light, continuous-wave lasers. For pulsed lasers and invisible wavelengths, other power limits apply. People working with class 3B and class 4 lasers can protect their eyes with safety goggles which are designed to absorb light of a particular wavelength.

Infrared lasers with wavelengths longer than about 1.4 micrometers are often referred to as "eye-safe", because the cornea tends to absorb light at these wavelengths, protecting the retina from damage. The label "eye-safe" can be misleading, however, as it applies only to relatively low power continuous wave beams; a high power or Q-switched laser at these wavelengths can burn the cornea, causing severe eye damage, and even moderate power lasers can injure the eye.

1.2 Objective

The objective of this work is to study the applications of laser on eye treatment and diagnosis.

CHAPTER TWO

2.1Glaucoma

Glintraucoma is discuses characterized by a pressure, which can lead to optic nerve atrophy and blindness. After the aqueous humor is produced by the celerybody, it travels through the pupil to scheme's canal, deep in the trabecular mesh work.

2.2Laser Eye Correction

It is also known as refractive surgery. It is a quick procure usually taken up t0 15 minutes per eye .The actual laser treatment consists of less than one minute. Duringthis process laser scans the eyes pinpointing hundreds of unique point on the cornea. Once this is done, the software used can determine exactly where the fault lies and ascertain the minor adjustment needed to the restore the sight back treasonablelevel. Thelaser then reshapes the cornea so the eye sight becomes at least 20/40 vision although in most cases it can be restored completely 20/20 vision.

The patient will be administrated with an aesthetic eye dropsprior to any procedure and a subtle restraining device placed on the eyes so there is no danger of blinking.

Most patients suffer from little or no discomfort and the recovery time after the procedure is very little and it is advised that on completion of the correction the eye must be rested until nextday.[14]

2.3 Laser in ophthalmology

Inophthalmology, various types of lasers are being applied today for either diagnostic or therapeutic purpose. In diagnostics, lasers are advantageous if conventional incoherent light sources fail. One major diagnostic tool is confocal laser microscopy which allows the detection of early stages of retinal alterations. By these mains, retinal detachment and also glaucoma can be recognized in time to increase the probability of successful treatment. However, our interest focuses on therapeutic laser applications. The first indications for laser treatment were given by detachments of the retina. Meanwhile, this kind of surgery has turned into a well-established tool and only represents a minor part of today's ophthalmic laser procedures. Others are, for instance, treatment of glaucoma a major field of research, too.

The targets of all therapeutic laser treatments of the eye can be classified into front and rear segments. The front segments cosists of the cornea,sclera trabeculum, iris, and lens. The rear segments are given by the vitreous body and retina.

2.4 Effectiveness of the Treatment:

Majority of patient have 20/20 vision or better following the treatment and better than when using glasses.

In patient over the age of forty it will be necessary to still wear reading glasses because they require for problems other than cornea problem that cannot be treated by correctional treatment.

There is a very low risk of infection, because most surgeons and clinics provide antibiotic and check up to ensure that the eye is reacting well to the surgery.

Also an enhancement may be required to correct the vision if surgery lead to over correction or under correction, but this rare, but still possible.

During a short period after treat Laser vision correction meant the patient may experience seeing halos around objects when viewed at night, but this should normally clear up after a week or so.

Touching or injury of the eye immediately after the surgery or within twenty four hours, this can lead to shifting of flap that is created during the treatment.

Laser Eye correction is now a mainstream treatment for the masses. Many people who wear glasses or contact lenses have considered laser eye correction because it is a painless, easy procedure that will fix eye sight.[15]

2.5 New Techniques in Laser Vision Correction

They are helping to correct nearsightedness,farsightedness,corneal scarring and astigmatisms. There are several procedures available such as:

1. Laser-Assisred in –Situ –Keratomilausis (LASIK)

In which the excimer laser precisely removes fine layer of tissues from the surface of cornea.

2.Epi-LASIK

Can be used to reshape the cornea without the use of surgical blades.

3.Customized LASIK or Epi-LASIK

Inwhichtheunique imperfections of each individual’s visual system is measured and addressed to provide them with the potential to experience better vision than is possible with glasses and contacts.

Another eye procedure available is astigmatic Keratotomy, where incisions are made in the cornea, in this case to correct astigmatisms.

An individual is most likely a laser vision correction candidates if her or she is free from significant eye disease and not too far_ or near _sighted.

And all patients undergoing refractive surgery require a pre-operative evaluation . This involves a number of specialized tests which will take approximately one hour. The information learned from these tests will be used to make sure the patients are good candidates.

2.6 Nearsightedness (Myopia)

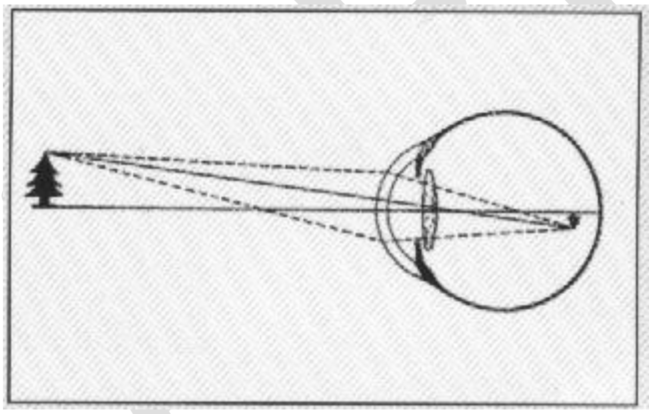

Figure (2.1): Myopia

Nearsightedness or myopia, occurs when light entering the eye focuses in front of the retina instead of directly on it . This is caused by a cornea that is steeper, or on eye that is longer, than a normal eye .Nearsighted people typically see well up close , but have difficulty seeing far away.

This problem is often discovered in school-age children who report having trouble seeing the chalkboard . Near –sightedness usually becomes progressivelyworse through adolescence and stabilizes in early adulthood. It is an inherited problem.

Chapter Three

RESULTS

3. Data obtained from Mekka Hospital [15]

3.1 Laser Types Used in Ophthalmology

The types of lasers :

3.1.1 Argon laser is used in retinal diseases. It causes small burns in the tissues to be treated in peripheral zones; they provide central retinal zones with oxygen and histotroph.

Argon is used in retinal peripheral zones more than in the center. Accordingly it prevents bleeding or rheum occurrence in retina.

3.1.2 Nd:YAG laser causes small explosions which lead to make foramina in zone to be treated. Nd: YAG laser is used in glaucoma treatment through making side slit in the iris body. It prevents the fluid accumulation and increases ocular hypertension. Nd:YAG laser also is used to remove the thin membrane which formed behind eye lens after cataract operation.

3.1.3 Excimer laser used in cases of vision correction for patients who suffer from near - sightedness (myopia) or farsightedness (Hypermetropia).

Also it is used in cases of retinopathy and eye lens membrane removal.

3.2. Laser Types Used in Surgery:

3.2.1 1000w Femto- Second Laser: It is used in eye lens front membrane removal as well as in some steps of cataract operation.

3.2.2 Vico Laser: They are micro sonic waves with high frequencies which make a small orifice in eye lens through which the head of a device is entered into the eye, in order to plant lens inside the eye.

3.3Advantages of lasers:

Laser solved surgery problems, particularly optometry, because it becomes almost normal and lifelong. Before using laser, surgery was used, but it has disadvantages. After period of time from the surgery an eye retromorphosis may occur, while in laser surgery (optometry) vision correction continues almost forever.

Laser minimizes risks, such as bleeding and ophthalmia. When Argon laser is used in treatment of retinal diseases, it takes short time and thus relieves retinal swelling caused as a result of diabetes. The success rate of laser surgery exceeds 90%, and currently laser is used successfully throughout the world for more than 20 years.

3.4 Follow-up in Laser Surgery

In using Nd: YAG laser in glaucoma surgery the patient should come back to the doctor after a week, because bleeding or aophthalmia is expected to occur.

In retinal surgery the patient should come back to the doctor after a month because burns expansion or aophthalmia is expected to occur, accordingly the patient needs to be followed-up for longer period, ranging between 3-4 months.

3.5 Retinal Diseases

Retinopathy caused by diabetes when weakness occurs in micro blood vessels leading to sweat fluids into blood vessels of retina causing vision weakness and deficit in oxygen feeding the eye. This motivates retina cells to produce new blood vessels (vascularization) to compensate the anoxia (lack of oxygen), these new vessels are fragile. They can lead to broken blood vessels causing bleeding inside or outside retina layers filling the eye vitreous membrane. This bleeding may cause fibrosis which leads to retinal stiffness and then to visual impairment. To treat such cases laser may be used to make blood vessel atrophy and reduce retina swelling.

3.6 Glaucoma

Glaucoma is ocular hypertension (increasing of eye blood pressure over the usual range). In arrow ocular angles case a side slit is made into the iris body in order to pass fluids outside the eye, this is done by peripheral iredectomy when surgery is used or iredotomy when laser is used. In such cases Argon laser is used to burn or beat a part of angle itself.

Glaucoma is divided into:

- Primary glaucoma which caused as a result of disease.

- Secondary glaucoma which caused as a result of a beat, bleeding or repeated aophthalmia.

- Congenital glaucoma.

- Cataract leads to glaucoma because it closes angles.

3.7 Side Effects of Laser Treatment

ND-YAG laser sometimes causes bleeding through the side slit in the iris body. It causes blood aophthalmia, and increases the eye pressure (ocular hypertension).

Sometimes errors happen when instead of hitting the iris body laser hits eye lens causing secondary Cataract.

There are no long term side effects in laser surgery, but sometimes when the retina is subjected to large dose, burns occur inside retina and may spread to neighboring tissues.

Generally, laser surgery is consider to be safe and few side-effects compared to surgery.

Chapter Four

Conclusion

Lasers have become very important in Sudan for eye treatment and diagnosis. The application is safe, bloodless and with minimum side effects.

References

1. *Gould, R. Gordon (1959). "The LASER, Light Amplification by Stimulated Emission of Radiation". In Franken, P.A.; Sands R.H. (Eds.). The Ann Arbor Conference on Optical Pumping, the University of Michigan, 15 June through 18 June 1959. p. 128. OCLC 02460155.*
2. *"laser". Reference.com. Retrieved May 15, 2008.*
3. *Paul Hewitt , Conceptual physics,* 2002
4. *Siegman, Anthony E. (1986). Lasers. University Science Books. p. 2. ISBN 0-935702-11-3*
5. *Nolen, Jim; Derek Verno. "The Carbon Dioxide Laser". Davidson Physics. Retrieved 17 August 2014.*
6. *Csele, Mark (2004). "The TEA Nitrogen Gas Laser". Homebuilt Lasers Page. Archived from the original on September 11, 2007. Retrieved September 15, 2007.*
7. *Covina, Calif , "Deep UV Lasers" (PDF), Photon Systems, Archived from the original (PDF) on 2007-07-01. Retrieved May 27, 2007.*
8. *D.Schuocker, Handbook of the Eurolaser Academy. Springer. ISBN 0-412-81910-4,*(1998).
9. C. Stewen, M. Larionov, and A. Giesen, "Yb:YAG thin disk laser with 1 kW output power", in OSA Trends in Optics and Photonics, Advanced Solid-State Lasers, H. Injeyan, U. Keller, and C. Marshall, ed. (Optical Society of America, Washington, D.C.., 2000) pp. 35–41.
10. F. J. Duarte, *Tunable Laser Optics*, 2nd Edition (CRC, New York, 2015).

11. *Charles H. Townes (2003). "The first laser". In Laura Garwin; Tim Lincoln. A Century of Nature: Twenty-One Discoveries that Changed Science and the World. University of Chicago Press. pp. 107–12. ISBN 0-226-28413-1. Retrieved February 2, 2008.*
12. Dalrymple B. E., Duff J. M., Menzel E. R. "Inherent fingerprint luminescence – detection by laser". *Journal of Forensic Sciences*, 22(1), 1977, 106–115
13. Dalrymple B. E. "Visible and infrared luminescence in documents : excitation by laser". *Journal of Forensic Sciences*, 28(3), 1983, 692–696
14. Samer Mohammed et al, Correcting Optical By laser, Science Laboratory, Graduation Project, Sudan Univercity of Science and Technology, Augst 2008 .
15. Dr. Fatima Khalid, Personal communication, Mekka Hospital, Khartoum, 2016.