

Medical application of Laser Technology

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Abstract

Laser technology has been of great importance and it has been extensively used in the recent years with remarkable success. It has many applications that makes it essential in everyday life. However, this technology is still open to numerous developments across multiple applications; there is particular focus in the field of medicine, for diagnosis as well as a research tool in biology. Today it is now well-demonstrated in ophthalmologic and dermatologic treatments, and surgery, one of the most fascinating aspects of laser technology is to perform fine dissection of biological tissues using a laser beam. The molecular examination of tissue for DNA, RNA and protein expression has revolutionized research and diagnosis in pathology. Conventional diagnostic and therapeutic approaches, another fields of application contribute to the development of treatment at the nanoscale level of laser technology, mainly the fields of cancer, leading to design new and innovative strategies in the drug delivery and the image-guided surgery. The aim of this present study is to present the origin of Laser beam and how beneficial and effective it can be for the treatment of various illnesses and their recovery.

Keywords: Laser technology, surgery, biological tissues

Introduction

The word laser is an acronym for Light Amplification by the Stimulated Emission of Radiation. Today laser light covers a wide range of wavelength which includes the visible range of the electromagnetic spectrum. The theoretical concept of Laser for the first time was given by Albert Einstein in 1917. Now laser has entered almost all the fields of science and has made a wide step of progress in many of them. Lasers are installed widespread in everyday life across multiple application: CD and DVD, barcode scanner, entertainment, welding or cutting in industry, aid to fire control or alignment of road and tunnels reported by Zaret, M.M.

Laser has become the modern technique of the 20th century. In medicine, it has become the beam that heals and has been utilized in nearly every type of medicine, diagnosis, therapy, surgery, and medical instrumentation. This technique is generally much less traumatic than traditional surgical technique as reported by Metelitsa. The First use of Laser in medicine was to damage the retina to understand ocular injury due to accidental exposure. Since the first ruby laser, several devices have been improved placing ophthalmology at the forefront of medical specialties using this technology. One should know something about beam properties, its origin and the requirements needed to provide such a beam; also one should know how to

handle the laser system and how to work safely, with an awareness of all possible hazards and therefore, taking all necessary precautions to avoid harm to oneself and damage to treated area reported by Grunewald S.

Many researchers have taken the technology to its limits by playing on two main parameters, the short laser pulses- to the femtosecond- and the energy beam. Since then, pulsed laser have become increasingly popular for their ability to ablate biological tissue.

As the tissue absorbs the laser energy, heat energy is produced and tissue damage occurs. Each tissue has specific absorption characteristics based on its composition and chromophore content. Infrared light is absorbed primarily by water, while visible and ultraviolet light are primarily absorbed by hemoglobin and melanin, respectively. As wavelength decreases towards the violet and ultraviolet, scatter or absorption from covalent bands in protein limits penetration depth in the range. When the laser light strikes tissue and absorption takes place, the cellular water is superheated to over 100°C. Intracellular protein is destroyed as the heat continues to build. The degree of thermal damage depends upon the temperature to which the laser energy heats the tissue. The depth of penetration of the laser beam depends upon the laser wavelength, color and consistency of the tissue, power of the beam, duration of beam exposure, and beam spot size. Laser surgery can be divided into three broad categories regarding tissue response: Thermal, mechanical and chemical effects. Breaking apart kidney stones in the ureter or disrupting the posterior capsule within the eye are examples of this type of mechanical effect reported by Vogel A and De Spiegelaere.

Properties of the Medical lasers

Properties of some medical lasers with several areas of application:-

The ruby laser: The ruby laser emits red light with a wavelength of 694 nm. The ruby laser system was used in retinal surgery, but weren't used widely for dermatologic work. Ruby laser light is strongly absorbed by the blue and black pigment, and by melanin in skin and hair. Current uses include

Treatment of tattoos

Treatment of pigmented lesions including freckles, liver spots, Nevus of Ota.

Laser Hair Removal

The neodymium YAG laser is in the near infrared spectrum at wavelength 1060 nm. It has a poor absorption by blood and is absorbed by water. This allows its use in the eye and other water-like filled cavities such as the bladder.

The helium neon laser is mostly used in students' laboratory for teaching due to the low output power of the laser beam.

The argon-laser beam is visible as a bright blue-green light of wavelength 488-515 nm. It is better absorbed by blood than the Nd:YAG laser, but its absorption in the water is less than of Nd:YAG laser. It is easily transmitted through clear aqueous tissues. The argon laser light is absorbed by the retinal pigment epithelium and the generated heat is then used to photocoagulate the retina. Dermatology and plastic surgery are other major areas of application of the argon laser therapy. The laser emission is in the mid infrared wavelength of 10.6 micrometer. This range is heavily absorbed by water.

The dye laser is used where a selective absorption characteristics of tissue upon certain wavelength is required in therapy; for example, in the treatment of port-wine stains, tattoos and other pigmented tissue. Currently, dye laser is used in photo radiation therapy (PRT), a new possibility for cancer tumor detection and treatment.

Laser surgery. It is a type of surgery that uses the cutting power of laser beam to make bloodless cuts in tissue or remove a surface lesion such as a skin tumor.

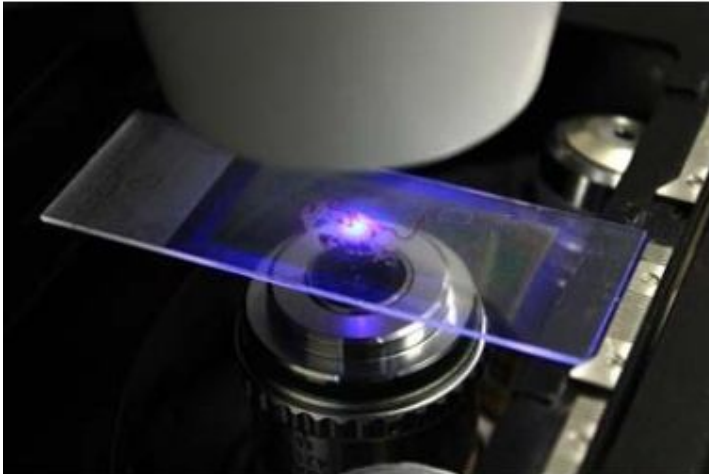


Fig. Blue light of a laser beam cutting a specific region, or cell of interest from a biological tissue laid after treatment on a microscope.

Gynecology: Gynecologists were among the specialists who first truly appreciated the potential of the laser. One of the first lasers they used was the CO₂ laser, which they found tremendously effective in treating patients with erosion of the cervix. New Gynecological application were introduced and with instrumentation refinements, the laser advanced laparoscopic surgery to a fine art.

Urology: Lasers were first experimentally used in urology within gas-filled bladders. The laser was inserted through conventional rigid cystoscopies with special deflecting prisms or shutoff windows to conduct the laser energy. Advances have led to the development of cystoscopes accessories and quartz fibers to conduct the beam through a fluid-filled bladder.

Dermatology: Laser is already being successfully used for cauterization and local treatment of skin growths and skin deformities. Laser treatments provides two major advantages over

conventional treatment in case of burn injuries and skin grafting. Laser finds wide application in dermatology in Homeostasis, which means stopping of bleedings and Removal of hair, tattoos, warty keratosis, cell carcinomas, and freckles. CO₂ lasers have been used for treating skin tumors[3].

Cardiology: Another important area of medical application of laser assisted balloon angioplasty, which has become very common in clearing blocked arteries.

Photocoagulation:- The laser produces a pulse of light energy as directed by the surgeon, which is passed to the eye under treatment. The pulse of light is focused by the lens of the patients 'eye to produce a minute lesion or coagulation of the tissue of the retina and the choroids.

Treatment of corneal ulcers: The applications of the lasers in the treatments of the eye disease are in corneal ulcers.

Laser in the treatment of the glaucoma: Glaucoma is caused by an increase in pressure inside the eye, which destroy nerve cells and causes vision loss.

Gastroenterology: Gastrointestinal diseases primarily include ulcers and tumors of the esophagus, stomach liver, gallbladder and intestine.

The purpose of this study is to provide such information in a simple form and find interest in the different fields of medicine, together with some application.

Objectives of the study

The objective of the study is to sensitize the rural population about the usefulness and availability of modern technology in the medical field namely the Laser technology and Ultrasound technology. It also aims to find whether such sophisticated yet effective technology is available in the highly populated Mahuadanr Block of Latehar District and if not, attempts to introduce them to the people through governmental and non-governmental organization. The objective also includes educating the common people about the advancement of technology and the extensive use of it in the medical field for diagnosis, treatment and improvement of a person's health in a faster and most effective manner.

Database and Research Methodology

Status of Laser Development in India

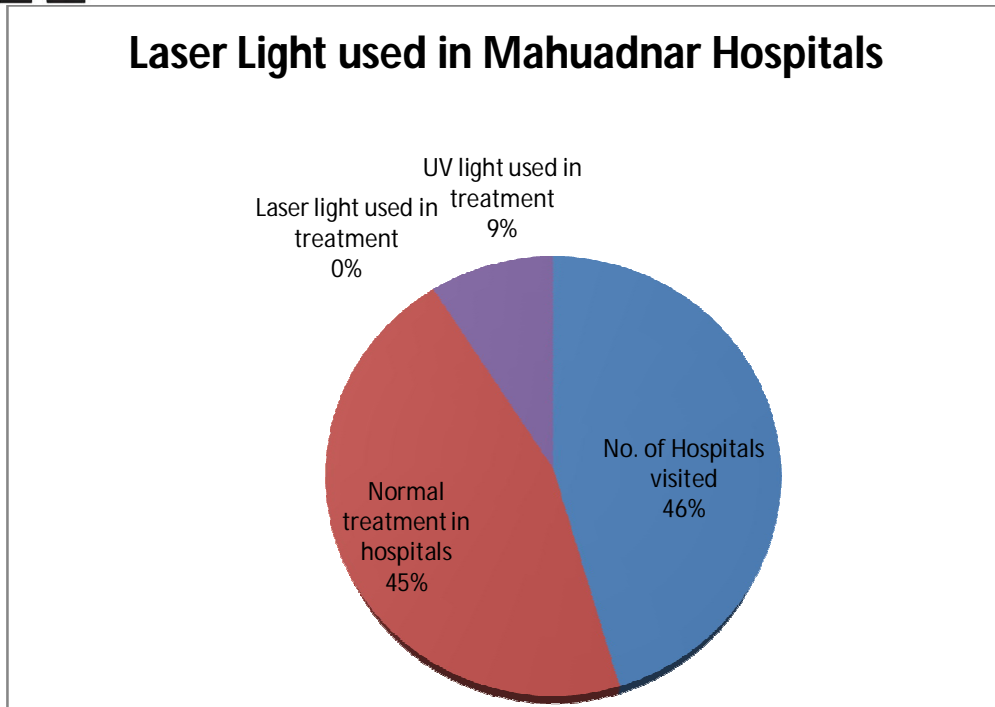
The research and the development work in the fields of lasers started in our country 28 years back on a very small scale at a few research laboratories of the Defence Research and Development IISC Bangalore. A number of research laboratories and teaching institutions also entered into this area. In 1988, Dr DD Bhawalkar, Director ,Centre for Advanced Technology ,Indore ,gave a status report on laser to Science Advisory Council to the Prime Minister.

Kind of the laser instrument		The instrument firstly used							Total
		1995	2000	2003	2004	2005	2006	2007	
Yag laser	Count	1			1		1	1	4
	% of Total	8.3%			8.3%		8.3%	8.3%	33.3 %
Argon laser	Count		1	1	1		1	2	6
	% of Total		8.3%	8.3%	8.3%		8.3%	16.7%	50.0 %
Excimer laser	Count				1	1			2
	% of Total				8.3%	8.3%			16.7 %
Total	Count	1	1	1	3	1	2	3	12
	% of Total	8.3%	8.3%	8.3%	25.0%	8.3%	16.7%	25.0%	100.0 %

Data collection during visiting hospital in Mahuadanr town.

1	Population of Mahuadanr	98646
2	No.of Hospitals visited	5
3	Normal treatment in hospitals	5
4	Laser light used in treatment	0
5	UV light used in treatment	1

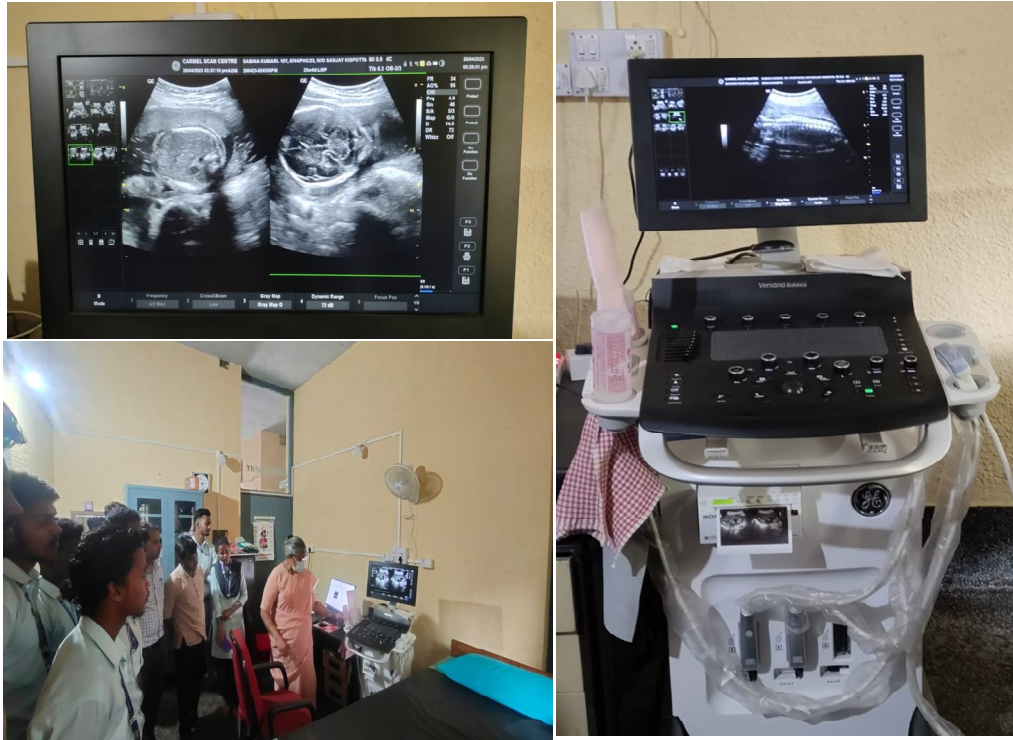
Pai Chat of the collected data:-



The population of Mahuadnar block in Latehar district, Jharkhand is nearly 98646. The number of hospitals in Mahuadnar is only 6 which is comparatively small compared to the population density. Nearly five hospitals were visited by the Department of Physics, St. Xavier's college Mahuadnar, Latehar. The common illness like cold, cough, viral fever, etc. are being treated in all these five hospital except one. Only Carmel hospital Mahuadnar has Ultrasound facility. By using Ultrasound machine, the images of the interior organs surrounded by liquid can be produced and the sickness can be diagnosed based on the image. Application of Laser Light in medical treatment is nil in Mahuadnar. This is a very critical situation for the people of Mahuadnar. If sickness is properly diagnosed right treatment can be given to the patients. There is no any laser surgery facility available in any of the hospitals in Mahuadnar. Laser light surgery has taken the place of traditional surgical procedure in the recent times in most of the cities. Modified newer laser continues to have large impact on various surgical practices. The people of Mahuadnar with high population density are in dire need of advanced technology in medical field.

There are many use of Laser in surgery as: To remove tumors, To help prevents blood loss by sealing small blood vessels, To seal lymph vessels to help decreases swelling and decreases the spread of tumor cells,

The most common use of laser light is in the operation of Kidney stone. According to a report of National Center for Biotechnology Information (NCBI), over 12% of the total population in India suffers from the problem of kidney stones due to unbalanced diet and unpurified drinking water. Lack of laser facility in Mahuadanr hospitals, the patients go to cities for further treatment and operation. On discussing with Dr. Annie Joseph, the doctor of Carmel hospital Mahuadanr, it is observed that the patients on getting the ultra sound image of kidney stone, is referred to the hospital in cities for the removal of it through operation.



**The
Laser
Future:**

In India CO₂ lasers are the most popular choice in the sheet metal industry. Time and willingness on the part of metal fabricator and process to invest in newer technology suited to the applications at hand could see solid state laser. Scientific Research lasers have opened new fields of investigations in science and technology. It has given physics a versatile tool for the study of interactions of light and matter. Laser beam can initiate and hasten chemical reactions. Since different reactions require different wavelength of light, a tunable laser is of immense help to a chemist. Tunable lasers, dye lasers, now cover the entire visible spectrum and have revolutionized optical spectroscopy. In photochemistry, lasers with short duration pulse are highly useful for inducing and monitoring ultrafast chemical reaction more efficiently than any conventional method. Laser also find application in biological research. Using laser techniques, biological studies have been carried out in enzymes, proteins, cellular compounds and isolated cells, microorganisms, tissue culture, isolated physiological system individual organs, etc.

Conclusion

The aim of this study is to show the different methods of the applications of lasers in medicine. Lasers are classified according to their active medium. Some of the important medical lasers are:-Neodymium-YAG laser, Argon Laser, carbon Dioxide Laser and dye laser. Laser has special properties that make it more important and useful than many other substances or instruments that are used in medicine. Some of its properties are: Laser light has small divergence of beam and it has high energy. It has proved its great ability and benefits in the different fields of medicine surgery because it reduces blood loss due to the operations cutting and including most of its branches i.e gynecology, ophthalmology, dermatology, and others. Moreover laser has short pulse of light. This reduces pain and yields more rapid recovery to the patients. In general lasers have many hazards, some of the important hazards are:- radiation, explosive, electrical and toxic hazards. Due to these hazards it is very important that all the safety precautions requirements should be available in the hospital where the laser system is used. These safety precautions are: laser instruments should only be used by qualified and experienced technicians, surgeons and physicians. These instruments must be kept away from those who misuse them. These instruments must be occasionally checked, tested and maintained.

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