



The Intersection of Laser Technology and Medical Physics: Current Developments

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Annotation: Laser technology has rapidly advanced across various domains, with particularly transformative impacts in medical physics. Despite widespread application, a significant knowledge gap remains in bridging fundamental laser principles with their safe and effective use in clinical settings. This review explores current developments at the intersection of laser physics and medical applications, highlighting the use of various laser types in diagnostics, surgery, dermatology, and cancer treatment. Through a multidisciplinary methodology combining literature review and case analysis, the study outlines how laser characteristics—such as wavelength specificity, coherence, and precision—enhance medical imaging, therapy, and surgical outcomes. Findings reveal improved targeting, reduced invasiveness, and enhanced therapeutic efficiency in applications ranging from ophthalmology to photodynamic cancer therapy. The results underscore the importance of interdisciplinary collaboration, innovation in laser design, and rigorous safety regulations to harness the full potential of laser

technologies in modern medicine.

Keywords: laser technology, medical physics, photodynamic therapy, laser surgery, diagnostic imaging, interdisciplinary healthcare, precision medicine.

1. Introduction

In the 21st century, it is difficult to find a healing facility where, in one way or another, medical technology would not interact, supplement, or partially replace the successes of traditional medicine. Part of such medical technology is therapeutic and diagnostic equipment, which is based on the use of laser technology. The development of laser technology in medical physics has created fundamentally new opportunities for treating visualizing information about processes occurring in biological objects. Efficient use of these possibilities requires knowledge in the field of physics and medicine. The purpose of this paper is to give a review of the fundamental principles of lasers and to consider how these principles are used to create several laser types used in medical technology. From the moment of the invention of lasers, the possibilities of applying these sources in various fields of technology have been actively explored. The promise was already in the name itself: "laser," as "light amplification by the stimulated emission of radiation." The contrast of the laser with an ordinary light source, such as a lamp or diode, is striking almost from the first glance: the laser spot on the wall from a distance of several meters is intense, sharp, and of a specific color, not scattering on the sides. Initially, the main emphasis in the application was on the military and communication fields, the birth of holography. Then, as technology improved and cost decreased, lasers began to intensively enter more peaceful areas of technology: processing materials of laser cutting and soldering, drilling, welding, marking production - all of these occupying a fairly secure piece of the pie for laser production. But equally impressive are the opportunities opening up for other areas of applied science. In medicine, methods of surgery appeared based on the high precision of the laser beam ("laser surgery"), cosmetology: removal of neoplasms of skin and blood vessels on the face, elimination of stretch marks, cellulite, etc. (where laser radiation was replacing the scalpel). One of the successful areas is low-intensity laser therapy - treatment of soft tissues with a laser beam of low power. A series of experiments revealed the healing influence of low-intensity laser radiation. A whole self-standing section of cosmetology has developed thanks to the possibilities of high-precision removal of tissues - a laser is one of the very few methods uniquely suited for this task. With the relentless increase in the performance of diode laser sources, new applications are emerging for this very reason it is worth trying to understand the essence of laser technology. [1][2][3]

2. Fundamentals of Laser Technology

Laser is a device created by luminance stimulated by the photons of unique frequency with certain characteristics: monochromaticity, parallelism, coherence, and high energy. Laser light is composed of photon packs generated by the movement of quantum energy levels. Energy levels in an atom are different energy zones that the electrons occupy when their attraction on the nucleus is opposed by the centrifugal forces. Every electron is gravitating around the nucleus in a certain energy zone (orbit). This zone is characterized by the main quantum number n , level, and the azimuthal quantum number l , and the orbit (O). Some special and very unlikely circumstances might happen, no net and sizeable energy can provoke inversion occurrence, which happens only momentarily. This is the moment when atom suddenly jumps into highly excited state conformed by the majority of electrons ($n = N_e$), and still with no emission, although it emits spontaneously. Finally, this stimulates the continuous emission of the photon with the same phase coherence and creates the laser light [4]. Laser is unique energy capable of

stimulating specific atoms within specific energy levels and creates discrete, coherent, powerful, and light parallel burst of photon packs. Unique features provide doctors with an exceptional tool for tissue ablative surgery, thermal surgery, tissue coagulation, and photo selective procedures for every wavelength as a laser beam. Most laser wavelengths are currently used in medicine, either in surgical treatments, diagnosis, or supportive therapy. Lasers with lower skin absorption illuminate by cutting the skin and are used during permanent hair removal, tattoo removal, treatment of spider veins, and many others. Diode fiber and Nd: YAG lasers perform in this manner. Lasers with a higher skin absorption wavelength therapy acute dermatological changes to discrete surrounding tissue damage. Therefore the skin reaction is predictable drying off shortly after therapy. Solid-state lasers such as CO₂, erbium, and KTP fall in this category. Some lasers are absorbed instantaneously by a given tissue and pass through it, only to affect the spotting tissue issue thickness, thus preserving other healthy tissues. Such a process is denominated photocoagulation and is applied to vein treatment and tumors and is usually performed by proper Nd: YAG laser using percutaneous light transport fiber carriers. The tissue removal capacity of surgical auto-bloodless ablation while performing the adipose tissue Liposuction is a method derived from selective photolysis principles.

2.1. Basic principles of laser operation

In general, the light can be created as a result of various processes and different sources like the sun, light bulbs, or light sticks. Contrary to this, specific features of lasers offer significant advantages over ordinary light sources. Exposing materials to the laser light can produce tissue ablation, coagulation, heat, or vaporization in a very precise way. The main components of laser systems are: gain medium, optical resonator, and source of energy or pump supplying the laser medium with energy to begin the flow of stimulated emission [4]. Optical feedback takes place in the laser cavity by two mirrors which are usually aluminum with high reflectance coating that ensures the light goes back and forth inside the resonator. Every laser has one mirror with less reflectance coating which allows part of laser light to be emitted and utilized. Gain medium (laser medium) contains atoms with energy levels suitable for the lasing effect. On the arrival of the photon with the same frequency as the frequency of the transition between states, another photon is released. Released photon and the photon that excited the atom are emitted simultaneously. This process is called stimulated emission and light as a result of it is coherent. The coherent light is spanned with long wavelengths, in parallel rays, and of the same frequency. Contrastingly, ordinary light sources emit light with various wavelengths, in all directions, and incoherent.

Quantum theory of light was established by Albert Einstein in 1917, which was foundation for the creation of stimulated emission and later, the laser. There are three main principles: light is emitted, absorbed, or light emitted simultaneously, and light is emitted when electrons go back to ground state. The lasing effect cannot be achieved without the prior establishment of the population inversion. The population inversion occurs when the majority of the atoms or molecules are in the excited state, which is the prerequisite for the stimulated emission. The purposes of using lasers in medicine are: wound healing, scar healing, ablation, tissue bonding, and soft tissue vaporization. Five basic output modes are: beam, pulse, carbonization, contact, and modified contact. For every type of therapy used in laser medicine, there is a specific output mode suited for it, adjusting energy and exposure time. However, it is important not to confuse mode of operation with type of the laser.

2.2. Types of lasers used in medical applications

The development of the first ruby laser in 1960 has led to expanded research of different laser systems and how they can be used in various applications, including medical. Therefore, types of lasers used for medical applications have undergone an extensive expansion both in number and kind varying from original solid-state to gas, dye, semiconductors, and today dominant fiber lasers. Non-ionizing lasers of particular wavelength and energy, depending on the domain of

their application, can interact with the tissue on either a superficial level or be able to pass through it and target deep tissue. These capabilities enable the use of laser systems in surgery as a form of scalpel, in diagnostics as therapy-imaging system, but also as a stand-alone therapeutic modality for various applications, among which is the subject of this paper – dermatology. Apart from specifications of the laser itself, parameters such as wavelength, energy selected for the type of clinical intervention also depend on the skin type, precision or power required for desired therapeutic outcome, but also on the level of safety for the patient [4]. Lasers belonging to an individual group of mentioned light sources can be engineered to generate emission wavelengths from ultraviolet (200nm) to far infrared (10 μ m). Due to the myriad of applications in medicine and recent technologies improvement, the development of new wavelengths also has the largest growth in recent decades. This important fact results in found and exhibited properties of lasers that are most suitable and applicable for treating different medical conditions to serve as a bridge on the gap of laser technology and its practical applications in the medical field. Regarding characteristics of lasers, all of the safety aspects (the potential risk of eye injuries, hazardous laser-beam exposure, and risks associated with direct/indirect and transient/continuous contact) shall be taken into consideration. Despite the relative novelty of medical applications, cases have already arisen that have led to tissue loss, where even amputation has been necessary.

3. Fundamentals of Medical Physics

Mankind's quest for harnessing light and its applications is as old as the pursuit of other technological achievements. Directing the emission of light to excise a disease offers the potential to greatly decrease the morbidity and mortality of such diseases [5]. The discipline of medical physics is taught to physicists educating on their basic multidimensional role in the healthcare systems and how the use of technology frequently advanced faster than their ability to understand the implications. 30% of all technological sales within the healthcare sector in the developed world concerns equipment, whereof a significant subset comprises laser technologies. Academically educated specialists are able to navigate in the cross field between physics, technology and medicine to ensure the safe and effective use of the technologies in healthcare this is known as the medical physicists.

The medical physics community can be divided into hospital-, academic-, and industry employed physicists. The discipline covers applications used at the interface of everyday medical practice as well as the front line of new innovative technologies, where the latter to a great extent involve developments in laser technologies. Medical Physics have a composite character with strong relations to other fields in physics, though the interaction with X-rays is most known. In this context, radiation therapy basics allow the utilization of high doses of radiation to treat malignancies. The principal offer works by ionizing the DNA of the cells, leading to cell death. Cells are divided into two general categories; normal and cancerous, where the latter has lost control of their division which is used for targeted treatment, assuming the cancer is identified early enough to apply this approach. Increased knowledge of the bio-physical response at the cellular and molecular level has translated into complex treatment delivery schedules with a multitude of radiation fields to deliver the dose accuracy needed for treatment planning mediated by software. Still, Arthur Conan Doyle's immortal character Sherlock Holmes asserts, "It is elementary, my dear Watson". In layman's terms, sometimes simplicity, "the old ways are the best", can achieve better outcomes. This latter pertains to the fundamental principle of the CT, MRI or PET scan that the media where the photons travel are of a simple nature: bone, water or air, wherefore it's elementary from a physicist perspective to predict their path. Understanding even basic principles behind the most commonly used imaging techniques such as X-ray, CT scan, MRI and Ultra Sound to name but a few, can give a blank slate a keen ability to discuss diagnostic outcomes. Currently, there is a considerable focus on sensing technologies, where the integration of lasers with these imaging modalities and novel treatment modalities, have demonstrated significant advances in diagnostic accuracy. Finally, an unhealthy fascination with death rays needed the establishment of radiation safety standards and the application of physics

to maintain stringent principles for patient protection. If the access between two places where a exposure value is registered, the intensity must fall off over the r^2 law, which in turn is a result of a decreasing number of photons mediating a high energy x-ray quanta. Here is hopefully laid some groundwork for readers to appreciate the growing relationship between laser technology and medical physics. With the aforementioned reading in mind, the following paragraphs likely will result in spin-offs into collaborative efforts beyond the simple development of one laser apparatus with one layout and league. [6][7][8]

3.1. Radiation therapy basics

Radiation therapy (RT) is the delivery of ionizing radiation to disrupt cellular processes within a designated region. Initially isolated cellular components and then whole cells are most easily killed through the activation of apoptosis. RT typically is held onto for more DNA damage strategies, as it disrupts DNA repair mechanisms and has a high potential for misrepair leading to chromosomal abnormalities. At higher doses, cells are often killed as the damage is too widespread [9]. Both different cell cycles (G0, G1, S, and G2/M) and cell mitotic statuses (quiescent, proliferating) are impacted by RT. Ionizing radiation directly leads to highly reactive free radicals which then will damage important cellular macromolecules. Indirect DNA damage due to replication products may also contribute to cell killing. DNA is the most important cellular molecule and damage to a critical number of locations can lead to cell death. The structure of DNA limits the methods by which it can be repaired effectively. All injuries cannot be fixed perfectly and the combination of injury and misrepair healthily limits the potential DNA can play in the cell. DNA damage can permanently or transiently arrest cell cycles which impacts the functioning of all cells. Over the lifespan of DNA repair enzymes, DSB become far less likely to be fixed properly. On the macro level, contrast with normal cell functions, cellular functions within the tumor are likely to be preferentially stopped leading to cell death which is the ultimate goal of RT. It is important to understand that the effectiveness of RT is multifaceted, and results from a complex series of events.

Horizontally delivered RT distinguishes the method of delivery from other techniques like brachytherapy. The use of RT following surgical tumor removal has the specific name of adjuvant therapy. Dosimetry in RT often is the combination of the intensity and space distribution of ionizing radiation. For standardization purposes, sources of radiation are often referred to in terms of their air-kerma strength. Treatment planning in RT is the determination of the distribution of absorbed dose in a designated treatment volume, in order to achieve a desired outcome. The goal of the MLC in RT is to conform the distribution of the radiation dose to respect the target normally while avoiding critical structures. It is also important to monitor render safe the thousands of radionuclide sources that provide more than half of RT treatments over the course of the year since 1995. Medically physicists are a necessary and crucial piece in the treatment of over 6 out of 10 cancer patients. In an ever more intricate field, MPG assure safe, effective, and consistent delivery of ionizing radiation that is involved in RT. To be a physicist and practice clinically, individuals must become certified by the American Board of Radiology in Therapy Physics.

3.2. Imaging techniques

Medical imaging is a crucial technique in the medical physics for the diagnostics, treatment planning, and follow-up of patients. Imaging techniques are used to visualize and evaluate the internal structures of the body noninvasively or minimally invasively. Modalities such as X-ray, CT, MRI, and ultrasound are used by different experts including radiologists, radiation oncologists, oncologists, cardiologists, internal medicine experts, surgeons, and emergency medicine experts for the noninvasive or minimally invasive diagnostics. This section involves the principles of imaging techniques, the role of imaging in the cooperation with radiation therapy, the impact of advances in imaging technology on the diagnosis, and the relationship between the advances in imaging and laser technology. Since adequate visualization of the

tumors and critical organs is vital for tumor delineation and treatment planning, imaging techniques are combined with therapy techniques like IMRT, VMAT, and SBRT. A new method is also suggested to increase the signal to background ratio in small tumors, which is difficult to visualize with routine imaging techniques due to the limits dictated by the quantum noises.

Medical imaging is a very essential tool in the diagnosis and follow-up of diseases. Conventional diagnostic imaging modality is, X-ray radiography. It provides a simple two-dimensional representation of the three-dimensional structures within the X-ray beam and is widely used for imaging fractures and deformities in bone. Due to similar densities, most soft tissues are hardly visualized in X-ray images. Computed tomography (CT) scans have significant advantages for the diagnosis of medical conditions that involve internal structures. It is a technique using computerized X-ray which takes cross-sectional images of the body. CT scans give much information compared to two-dimensional X-ray radiography and can detect a far wider range of visual problems. Magnetic resonance imaging (MRI) is a way of looking at physical and biochemical effects in the body by using a large magnet and radio waves. It values medical conditions which results in variations in nuclear spin relaxation. In general, MRI provides a far clearer visual representation compared to CT or X-ray. MRI is predominantly used in imaging the brain or inner ear. In one of its more widespread uses, it may allow to investigate pathology (tumors, as one example) within soft tissues such as the liver, kidneys, bladder, and so on. Ultrasound (US) imaging is a technique which pictures internal structures using high frequency sounds. AssemblyTrademark include tissue density and distance to the sensor. Broadly, CT, MRI, and US are the primary modalities used where the disease is located internally.

4. Applications of Laser Technology in Medicine

A very reduced focus on the actual regular medical application. There are a number of medical disciplines that might benefit by the application of Laser technology that can be used in a more rational way. Here some remarks about other important discipline shorter presented elsewhere:

1. Lasers in Dermatology and Aesthetic Medicine

Laser treatment in surgery is a procedure often presented; in Dermatology, Venerology and Aesthetic Medicine however, Laser technique by now became the main treatment procedure. To the layman the usage of Laser also in medicine application can have a fantastic attraction. Reading the goal however, the effect is mostly therapeutic in the restricted conservative sense. One of the big fields of application for instance is the removal of unwanted tattoos. Using an Q-Switched ruby or alexandrite laser an energy high enough to break the pigment is brought for short time into the skin. The absorbed energy is transformed into heat and photo-acoustic shock waves breaking the pigment which can than be removed by the macrophages. The result also in this Laser industry is always good. Treatment had to be repeated several times, but with enough time between the reactions are minimal. Laser technique can be used in the same way also for nevi, lentigines and other benign pigmented lesions.

2. Industrial Medicine

Also in industrial medicine application, Laser technique by now has some importance. This is especially true for low level Laser application. In the field of Laser acupuncture or laser biostimulation (both the same) a lot of research results, most of them not valuable, because of the generally bad quality of the performed studies. From a Bioengineering or Physic Engineering view a potential in this technique was not to see either. [5] present a new flexible fiberoptic Laser system that is nice for surgery as well as for acupuncture. Others developed an improved system of small lasers for acupuncture. The erection of the interested point should be improved by a diode laser. In practice the wavelength of 632 nm is extremely bad absorbed by dark pigmented skin.

4.1. Surgical procedures

The laser surely has known an exceptional development and diffusion in the surgical field, and today it may be well considered as a tool that can be employed (at least as a primary intention) in every surgical application [10]. The great effectiveness of the laser in making possible a series of surgical operations that would be unthinkable with conventional methods has from the beginning been showcased through experimental works and clinical applications. The main advantageous applications of the laser in surgery are mainly related to the possibility to cut or drill tissues with high precision, avoiding damages to adjacent tissue layers, good hemostatic properties, low postoperative pain, and the possibility to develop new techniques difficult to perform with conventional instruments. Laser cutting is a very precise technique: in comparison to surgical scalpels which can be extremely sharp, the width of a laser cut may be measured in only microns. Without the direct contact between laser and tissue, affected tissues are 'vaporized' rather than 'cut'. Also, coagulation using lasers bleed less than the conventional methods. The use of lasers in surgical procedures is increasing also thanks in part to the possibility of designing specific lasers that can be adapted to the characteristics of the particular surgical application [5]. Such interventions, compared with traditional surgery, enhance effectiveness by simplifying complex operations and reducing trauma. Good clinical outcomes have been observed in the treatment of hyper-reflective macular holes and retinal detachment pathology, an innovative approach based on the pre-processing of the epiretinal layer with picosecond laser pulses. This approach greatly facilitates the removal of an otherwise highly difficult epiretinal film and makes the forcing drainage of fluids almost unnecessary. However, to fully use the potential of the laser in surgical applications requires adapting these procedures to suit best the implementation of the chosen laser source as well as the skills of the operators. To accordingly perform laser surgical procedures, the physicians must be effectively trained and require a set of skills specific for laser surgery. In addition, the safe use of lasers implies that adequate safety criteria, protocols, and regulations are in place to minimize accidents and damages.

4.2. Dermatology and cosmetic treatments

Lasers have revolutionized the field of medical physics over the past few decades. From the variety of laser technologies to how and where they can be integrated into the medical field, the innovation of lasers as treatment and diagnostic tools is vast and ever-changing. Examples of new and innovative laser treatments are uncovered all the time. But with many common treatments, there are also forms of them that are medically necessary. The use of lasers in the medical field opens up new, more precise, and minimally invasive treatment pathways for patients. When thinking of laser treatments within the medical field, the most common types are often thought of. For example, laser pointers are used for physical tours to help the audience see the presentation screen. Not many other industries or businesses use lasers regularly.

That is why it is important to consider the intersection of laser technology within a scientific field such as medical physics. The first thing that may come to mind may be Laser Cooling, which won the Nobel Prize in Physics in 1997. There are many other applications of lasers in physics and there are currently new areas of development that have not yet been fully explored. In how lasers are understood, from a physics standpoint, it is key to understand exactly what they are. Lasers are essentially focused light sources that have been amplified to have a much higher intensity than other light sources such as light bulbs. What sets lasers apart from natural light sources is that the light can be focused down to a very small point to provide a very intense beam. This is why it is so useful in many applications, especially conditions related to the skin as the direction and intensity of the beam can be extremely controlled [4]. All lasers are different in this regard and each has its own specific use.

5. Challenges and Future Directions

In the past decade, a population-scale research and development effort has led to the most powerful, compact, and efficient high-intensity laser-based x-ray source worldwide, providing

pulsed high quality beams. This thrilling technological leap crossed it in no time ahead of widely considered and well-funded similar developments in various countries where laser and plasma physics is strong. Yet, from a medical physics point of view, it's the cancer treatment and therapy enhancer outcomes that are more interesting than the sources themselves. The annual number of published papers dealing with any biomedical or clinical application of these x-ray sources also increased several times within 5–7 years since the multi-terawatt capability was achieved.

Given the commercial confidentiality that naturally surrounds much of the equipment used for laser-based cancer treatment together with the diagnosis, it's difficult to add significant insights. The results summarized below are based on publications unclassified or older than 3 years since annual exhaustively reported results of patient trials and pre-clinical experiments. Meantime, some material on the potential benefits and pitfalls of high-Z elements and their use in future research mainly to stimulate the curiosity of medical physicists and to arouse the desire to connect with the interested researchers.

5.1. Safety concerns and regulations

Injuries to the eye from laser devices may have resulted from lasers that were not intended for biological applications, or from commercial lasers at very high intensities. The inadvertent reflection of a laser through the line-of-sight or off a reflective surface can cause ocular pain or injury. The direct exposure of a Class 3B or a Class 4 laser to the skin may cause thermal burns, and constituting medical attention was needed in the most severe cases [11]. Since 1993, laser pointers of Class IIIa or higher have been illegal in the United Kingdom due to accidental retinal injury. People have been charged with felony assault for flash-blinding police officers with green laser pointers, with resulting eye injury. In March 2013, a cosmetic skin laser offshore returned to the United States with a macular retinal hole from a commercial grade laser in his right eye. The likely delivery parameters of the laser exposure, in both commercial and medical setups, were determined by the laser fluence formula. For all measurements taken, the maximal output per unit surface area was found to be above the safety limit imposed by the American National Standards Institute [12].

5.2. Potential for enhanced precision medicine

Over the last 50 years, the development of lasers has created new tools for physicians that have enabled them to devise new procedures that help patients more safely and effectively. As a result, lasers have enriched all areas of medicine including surgical industries and the diagnosis and treatment of milder conditions. Indeed, laser illumination has been established as treatment in numerous cases. Contrary to other illumination sources, lasers have amazing features permitting site-specific elimination of morbidity tissue or transfusion of healthy tissues depending on the operating wavelength, power level, exposure period, thus directly affecting only the necessary limited volume of biological matrices. Such an opportunity can diminish the side effects of treatment and reduce the severity of the inevitable consequences. Lasers aid in the cure of treatment outcome techniques in conjunction with simultaneous or subsequent exposure on the medical pipeline layer healthy or genetically modified. On the other hand, the theory and biology of the influence of laser light on matrix as well as many procedural recommendations are still not clearly specified. Yet, laser irradiation with several wavelengths in the set of regimes has been frequently systematically applied for those patients with selected or wide variance of pathology such applications are used and prescribed in high-level tenderness tissues and organ reservoirs that have unique lesions or possess some hereditary disease.

6. Case Studies

Lasers are present today in almost all fields of medicine – the ways is highly versatile. The flexed spot of a CO₂-laser is used for laser-acupuncture on an ear. A Q-switched Nd:YAG laser functioning on a frequency quintupled base was used for an image forming technique analogous

to coherent image converting [13]. These examples show the open and complex world of “the laser in medicine,” selected from the large area of 40 submissions on the subject at the FIL-98. Up-to-date methodological and editorial aspects are expected by the readership of the Journal of Clinical Engineering. Clear and easily understandable demonstrations or explanations in the 500 words are much appreciated. Within that frame, case studies of a CO₂-laser used for snoring and of a Nd:YAG laser in the MR tomography will be given. Control of tissue destruction is a fundamental prerequisite for application of laser light in surgical procedures in modern gynecology. Light induced thermotherapy (LITT) for the coagulation of human endometrium is presented as an example of therapy action. This study reports on the evaluation of the duration of tissue coagulation as a function of the delivered energy and the effect of a hydrothermal pretreatment of the target tissue for LITT on the coagulation depth. The results give directions for critical parameters of the LITT setup such as fiber design, transmission energy and irradiation geometry. In laser roentgenometry, a high power nanosecond range Ne-Blaser is used for the generation of a spatially selective X-ray source in the energy range required for projection roentgenography of dense packages. By the use of Lyman X-radiation of nickellike neodymium and the increased sensitivity of registration to the X-ray source, the possibilities of X-ray image forming techniques offering the advantages of the coherent image converter are investigated.

6.1. Laser-assisted eye surgery

The use of lasers in surgical procedures has had a revolutionary impact on the medical field in the last quarter of the 20th century. Without a doubt, one of the most discussed and earliest applications of laser technology in medical physics and medicine is laser-assisted eye surgery. Procedural advancements, which were unimaginable before the introduction of laser technology, are now considered routine in the correction of refractive errors. These corrective methods are not only more precise and safer but also permit quicker rehabilitation with improved results. Further advancements are being made every day to improve laser-based surgical techniques with practitioners being given the technologies to alter and fine-tune them to achieve optimal results for the patients under their care.

Before addressing the basic working principles of lasers in ophthalmology, the greater part of this text looks at the applied side of laser surgery from the perspective of patients. The overall good results of this surgical technique are often highlighted, but it is often less emphasized how great a role the overall process – beginning with competent preoperative assessment and culminating in careful postoperative care, particularly during the two week healing process just following the surgery – plays in the recovery of the eyesight. Instead, the focus tends to fall on a fairly simple and shortened portrayal of the procedure itself, emphasizing above all the safety and precision of the instrument utilized in the treatment process. And rightly so—it is important that patients feel a certain security when the object of the procedure is their vision. It is also important that a potential patient know the basics and a few specifics about laser-assisted vision correction; in this way, expectations will be closer to the actual results.

6.2. Laser therapy for cancer treatment

The application of laser systems continues to broaden within the field of medical physics. The state-of-the-art developments of laser systems and innovative technological modifications influence the treatment and therapy options in modern high-tech patient care profoundly. Indeed, new methods of ambient and invasive laser systems are developed and integrated for therapeutic strategies more and more in various subfields of medicine but also in surgery, oncology, radiotherapy, and immunology [13].

In case of laser application in cancer treatment, laser therapy has been used to treat patients using various therapeutic strategies. Besides the well-established treatments like photodynamic therapy or laser ablation, laser therapy has been applied in some unique and newly emerged methods. Clinical studies have shown the promising outcomes of nasopharynx cancer, prostate cancer, and cutaneous metastatic breast cancer using laser therapies. Malignant tumors are still important

health issues with high mortality in the world, and the combination of various therapies to enhance the treatment planning is necessary and of broad interest amongst the literature. In addition, situations from patient's perspective, the accessibility and acceptance of using laser therapy for the management of cancer are discussed. Some of the patients with preferable treatment will choose to go to other countries where more advanced techniques are available [14]. Therefore, the distribution of the advanced techniques is uneven and not generally accessible to patients all over the world. Considering the potential of laser such as biocompatibility, sterilization, and high penetration of light, some emerging methods in comparison to conventional cancer therapy are highlighted. Besides the well-established treatment like the photodynamic therapy and ablative therapies, there are several unheard of methods aiming at killing cancer cell with the laser have appeared in the past 5 years. In order to meet physicians' requirements of a minimally invasive operation, these ultra-low invasive laser therapies have shown excellent performance for cancer treatment especially the laparoscopy. More innovative laser systems and methods with microscopic precision for the stimulation and surgery of organs and tissues have been developing and testing at the clinical level. Institutionally, technical and experimental conditions are provided to ensure laser safety and advanced user access. So far, coagulation lasers, lasers for photodynamic diagnostics, thulium, and Ho:YAG lasers for stone therapy, computed high-power lasers for rapid opening of clogged arteries, UV and picosecond systems for tattoo removal are successfully used in medical practice. [15][16]

7. Conclusion

Recently, laser technology has advanced rapidly, changing the landscape of medical applications in various forms, improving medical safety and precision and often opening completely new treatment methods. A significant part of the development is the advances made in the understanding of the effects and principles of laser radiation and in its practicable interpretation through legislation. However, bringing laser technology into medical use has been seen to be challenging for both the medical and engineering sides. As research and development continues, new possibilities are opening up and the use of lasers is expected to expand. Increasing cooperation between medical and engineering sides is expected to bring methods of bringing research knowledge more rapidly to application, and to crystallize means of interpreting research needs between the disciplines involved. The detailed definition of the properties of time-dependent laser devices should also be the key question for the development of better regulation and legislation in the field of lasers, to ensure the safety and efficacy of laser applications in medicine. Healthcare has undergone remarkable progress in the last centuries and decades. From the rudimentary methods available in antiquity through the significant advances made in the 19th and the early 20th century, healthcare providers have developed methods and technologies that keep death away. The one particular technology that is believed to change the future of healthcare significantly is laser technology.

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