LASER: The Light That Heals

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The instant images that leap to one's mind at the mention of the word "Laser" are of star wars and light sabers. The word has connotation of power almost akin to magic. The term LASER is an acronym that stands for Light Amplification by Stimulation Emission of Radiation. Laser is not a device; it is a phenomenon that has been applied for specific uses in a wide variety of fields particularly in medicine. For all its variety of applications, the principle behind the laser is quite simple; when an atom or molecule absorbs energy, electrons or molecules move into higher orbits and fall back almost immediately into lower orbits, as the electron molecule falls back into the lower energy level, a spark of surplus energy bursts out, this surplus energy is the "photon", the basic unit of light. The stimulated emission used in laser takes place when a photon stimulates another atom in its path to emit an identical photon thus creating waves of light that are in perfect phase with each other. In a laser chamber which contains active medium, these waves of light are reflected back and forth by mirrors increasing in power and brightness with each reflection. The result is a highly monochromatic, directional and coherent light, referred to by the active medium, e.g., Argon Laser, Carbon Dioxide Laser, etc.

Merely understanding the principle of the laser does not explain how this wonderful occurrence is harnessed in so many medical fields. In King Faisal Specialist Hospital and Research Centre, the laser is now used in different medical applications superseding some traditional methods of healing and diagnostics. Dr. Farouk A.H. Al-Watban, Principal Scientist, Laser Research in Biomedical physics Department of Research Centre whose specialty is laser radiation and photodynamic therapy says there are different types of lasers. There are for example the CO2 (Carbon Dioxide) laser, the ND: YAG (Neodymium: Yttrium Aluminum Garnet), Argon, KTP/532 (Potassium Titanyl Phosphate) laser, dye, Holmium and Excimer lasers.

Each kind of laser exhibit properties that make it suitable for specific medical applications the depending on its interaction with tissue. Dr. Watban says, “What is the laser tissue interaction? We look to the main constituent of the biological material which is for instance cellular water, or the hemoglobin, or the melanin. The spectral absorption of that particular wavelength of laser by any of these will help the doctor decide which laser to use.” Laser is used in surgery for cutting, vaporizing, coagulating, and welding tissue which are all the result of heating the tissue. There are several other effects on tissue which cannot be elaborated on in this summary for lack of space. The most commonly used laser in surgery today is the Carbon Dioxide (CO2), Dr. Al-Watban says, “The CO2 laser wavelength is absorbed heavily by the cellular water. It is the surface absorption that makes it

excellent in surgical procedures. The CO2 laser is different from normal knife scalpel. When you cut with laser, whether with a hand piece or micromanipulator coupled with a microscope, you are at a distance from the target. This provides sterilization by vaporizing all existing bacteria and virus in the field. Small lymphatic ducts and blood vessels will be sealed automatically. The widest field for CO2 laser usage is in Gynecologic procedures such as the treatment of premalignant diseases as well as genital infections. With the help of a surgical microscope or colposcope, one can achieve fine control and focus of the laser to vaporize the diseased tissue while causing very little damage to the adjacent healthy area. CO2 lasers are also used to a considerable extent in otolaryngologic surgery to treat airway obstructions, tracheal stenosis, vocal and oral tumors as well as general surgery, orthopedic surgery and neurosurgery.

Laser is one of many therapeutic applications of flexible endoscopes. The disadvantage with using CO2 is that it cannot be used through fiber optic cables and for this reason is not used for endoscopic procedures. It is the ND: YAG laser which is used for some endoscopic procedures. Dr. Al-Watban says," because of its absorption characteristics, it penetrates more deeply into tissue that CO2. It can coagulate blood vessels at low power densities to treat vascular tumors and vaporizes tumor at high power densities for treating esophageal carcinomas. This laser transforms the endoscope to a therapeutic tool. It is also

used in dissecting structures such as the gall bladder using contact tips through the natural opening of the human body thereby reaching the internal organs without the need for major surgery.

The Argon laser is primarily absorbed by pigmented tissue such as hemoglobin and melanin. The first medical application of the laser was in ophthalmology, the first laser used was the ruby laser for retinal detachment. Afterwards, the Argon laser was used for neovascularization especially for the young diabetic. Various lasers are used today for treating glaucomas, opening up cloudy posterior capsules after cataract surgery. The progress in laser ophthalmology continues today with the current studies on Excimer lasers.

The Excimer laser has a very special cutting action and can be used with great precision for radial keratotomy, astigmatism and corneal transplants as shown in recent studies. This laser is also finding its way to cardiovascular procedures particularly angioplasty. The latter procedure is now called angioplasty, Dr. Al-Watban says, “the Excimer laser is different from other lasers because other laser are all thermal lasers which means they have a melting property. Excimer lasers have an ablation property. The Excimer laser breaks the actual chemical bonds of the tissue and there is no doubt that for laser angioplasty is a great interest. However the procedure needs many controls, more basic studies and prolonged periods of observation. Now there are number of centers which do atherolysis of peripheral vessels in patients and soon we

hope KFSH will be one of them. However, for actual cardiac surgery, stenosis, and myocardial revascularization, the CO2 laser has been used for sometime."

Apart from these fields, lasers are used in the hospital in the fields of physical therapy for pain control and wound healing, this field is called BIOSTIMULATION. It accelerates the sluggish flow of the lymphatic system, speeds the vascular flow and restores natural analgesic substance. There are several lasers throughout KFSH&RC including several Argon Lasers in ophthalmology, ND: YAG lasers in the operating room and endoscopy unit, a CO2 laser in the operating room and Argon Dye pumped laser in the Research Centre. In Neurosurgery, lasers are used to vaporize specific, highly vascular tumors, or tumors in specific locations. Some Neurosurgeons are investigating the possibility of treating other pathological conditions, such as herniated intravertebral disc, using laser through an endoscope.

The effective use of lasers also requires adherence to safety procedure. Users need to be continuously educated in safety practices. The correct protective eyewear should be worn. There should be adequate ventilation and respiratory protection against airborne contamination. Precautions should be taken against fire from the presence of flammable materials as well as electrical hazards.

Another significant use of laser is in Photodynamic Therapy (PDT) in which a photosensitizing agent such as dihematoporphyrin (DHE) or Hematoporphyrin derivative is activated by an argon dye pumped laser in the treatment of malignant tumors. Dr. Al-Watban says PDT may be used in lung, bladder, esophageal, gynecological, eye and skin cancer. PDT is not presently offered in KFSH&RC although it is now widely used in many areas of advanced medical development.

There are several distinct advantages in using lasers in clinical applications: dry surgical field, reduced blood loss, reduced edema, limited fibrosis and stenosis, no interference with monitoring equipment, reduction in metastasis, precision, reduced postoperative pain, reduction of anesthesia and greater ability to carry out outpatient procedures, sterilization of the site and reduction of contact. All these advantages also result, as Dr. Al-Watban points out; it reduces hospitalization and decreased medical costs for the patient.

There is a need to appreciate and promote new laser applications in medicine in view of its widening usage in many fields all over the world. It is to the advantage of the hospital to keep abreast of the most up to date developments in this field as far as competition with other medical institutions is concerned. But beyond this consideration are the tremendous medical benefits to be reaped from the laser phenomenon. Laser is no longer a figment of science fiction; it is a reality that serves our needs today.