

# Medical applications of lasers – progress of technology

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Soon after the first working laser was developed in 1960, researchers began studying the medical uses of lasers. Lasers were first used medically in 1961 to treat a type of skin discoloration and to repair detached retinas. Presently, lasers are used more and more widely. This article is intended to enumerate only a fraction of the laser applications used in medicine.

Laser surgery is a pioneering field of medicine. The laser is used for some type of procedure in practically every speciality field. Doctors are researching the laser for even more increased use because it provides a noninvasive, quicker, and less painful approach to many procedures. In the future, the laser will become an increasingly common-place medical tool.

Although there are several different kinds of lasers, mainly three kinds have gained wide use in medicine:

- CO<sub>2</sub> – This is mainly a surgical tool. It can cut or vaporize tissue with relatively little bleeding as the light energy changes to heat.
- Nd:YAG – Light from this laser can penetrate deeper into tissue than light from other types of lasers, and it can cause blood to coagulate quickly. It can be carried through optical fibers to less accessible parts of the body.
- Argon – This laser permits superficial penetration and is useful in dermatology and in eye surgery. It also is used with light-sensitive dyes to treat tumors in a procedure known as photodynamic therapy (PDT).

Lasers have several advantages over standard surgical tools:

- Lasers are more precise than scalpels. Tissue near an incision is protected, since there is little contact with skin or other tissue.

- The heat produced by lasers sterilizes the surgery site.
- Less operating time may be needed because the precision of the laser allows for a smaller incision.
- Healing time is often shortened; since laser heat seals blood vessels, there is less bleeding, swelling, or scarring.
- Laser surgery may be less complicated. For example, with fiber optics, laser light can be directed to parts of the body without making a large incision.
- More procedures may be done on an outpatient basis.

There are disadvantages with laser surgery:

- Relatively few surgeons are trained in laser use.
- Laser equipment is expensive and bulky compared with the usual surgical tools, such as scalpels.
- Strict safety precautions must be observed in the operating room. (For example, the surgical team and the patient must wear eye protection.)

Lasers were first used on skin tumors in 1961, and today one of the most common medical applications of lasers is in cancer treatment. They can be used in two ways to treat cancer: by shrinking or destroying a tumor with heat, or by activating a chemical - known as a photosensitizing agent - that destroys cancer cells. In PDT, a photosensitizing agent is retained in cancer cells and can be stimulated by light to cause a reaction that kills cancer cells.

The CO<sub>2</sub> and Nd:YAG lasers are used to shrink or destroy tumors. They may be used with endoscopes, which allows physicians to see and work in parts of the body that could not otherwise be reached except by surgery and allows very precise aiming of the laser beam. Lasers also may be used with low-power microscopes, giving the doctor

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a clear view of the site being treated. When used with a micromanipulator, laser systems can produce a cutting area as small as 200  $\mu\text{m}$  in diameter – less than the width of a very fine thread.

Lasers are used to treat several kinds of cancer in the digestive system, to treat abnormal tissue and carcinoma in situ and very early cancer of the cervix, vagina, and vulva.

Cancers of the head and neck and the respiratory system are treated (but usually cannot be cured) with lasers. Treatment with lasers for small tumors on the vocal cords may be an alternative to radiation for selected patients. Lasers can be used to shrink primary and secondary brain tumors, which may help relieve symptoms. Laser surgery for breast cancer is becoming more common and may result in a shorter hospital stay and less pain for the patient.

The ruby laser, operating either in a Q-switched or free running mode, and Q-switched ND:YAG provide effective, economical tattoo and pigmented lesion treatments. Presently, the ruby laser is also being tried for use in the removal of hair.

An argon laser is used in PDT. This treatment is based on the discovery, made over 80 years ago, that certain chemicals can kill one-celled organisms in the presence of light. Recent interest in photosensitizing agents stems from research showing that some of these substances have a tendency to collect in cancer cells.

The photosensitizing agent injected into the body is absorbed by all cells. The agent remains in or around tumor cells for a longer time than it does in normal tissue. When treated cancer cells are exposed to red light from a laser, the light is absorbed by the photosensitizing agent. This light absorption causes a chemical reaction that destroys the tumor cells. Light exposure must be carefully timed to coincide with the period when most of the agent has left healthy cells but still remains in cancer cells. There are several promising features of PDT: cancer cells can be selectively destroyed while most normal cells are spared, the damaging effect of the photosensitizing agent occurs only when the substance is exposed to light, and the side effects are relatively mild.

In dentistry, lasers are becoming increasingly popular. Many people suffer from tooth sensitivity

which causes pain at the extremes of temperature, both hot and cold. This pain is the result of an exposed dentin layer and possibly the root when the gum has been stripped away through aggressive brushing. Lasers can seal the area and eliminate the sensitivity. Lasers can also be used to remove tooth decay, remove canker sores, harden plastics used in place of metal fillings, and destroy certain oral cancers. Lasers are helping to reduce the pain associated with most dental procedures.

In orthopedics, the laser is used to treat some common ailments of the knee, shoulder, and back. Lasers remove torn tissue in arthroscopic knee and shoulder surgery which is often in areas inaccessible to standard tools.

At the cutting edge of laser surgery are the eye clinics. People who suffer from poor vision due to myopia are now enticed by the latest high-tech procedure to correct nearsightedness. Correction of myopia and astigmatism is achieved through the most technologically advanced medical procedures available today. It reduces a patient's dependency on glasses and contact lenses. The laser itself reshapes the front surface of the eye with the use of a cool ultraviolet beam of light energy, which brings light into the retina.

Although lasers have proved to be successful in many areas of medicine, they have caused many problems and complications in cardiology. Originally, lasers were hoped to improve angioplasty which clears arteries by expanding a balloon in blood vessels. Lasers were hoped to be able to open regions of total blockage or where the balloon could not travel. The catheters of laser surgery are too stiff to wind their way throughout the coronary arteries. Therefore, the use of the traditional balloon provided fewer complications.

Although lasers have many diverse uses and have helped to simplify many medical procedures, some of the risks are often unmentioned. Lasers can cause burns and damage to vital organs if used improperly.

Lasers are gaining increasing popularity in the medical field because of their broad application, efficiency, and improvement in overall ease of the procedures in which they are used. Unfortunately, many doctors are using the laser as a marketing tool to make them appear more high-tech, but

lasers are certainly more than that. In fact laser surgery may be less expensive than other types of surgery. Doctors and dentists believe that the laser will follow the example of the calculator. Calculators originated around \$300 and now can be purchased for \$10, so what about lasers?

This technology has also other aspects, as we heard recently: Herbert Schwind GmbH (Kleinostheim, Germany) will pay Summit Technology (Waltham, MA) about \$800,000 for patent infringement. The judgment, obtained in Germany, stated that Schwind's Keratom ophthalmic excimer-laser system infringed the patent Summit held for Azema technology. Before this payment, the validity of the patent was sustained in a German-court nullity action.

Summit recently obtained a separate judgment against Chiron Technolas (Emeryville, CA). The decision stated that an ophthalmic excimer-laser

system produced by Chiron infringes the same patent. Summit has also brought separate infringement actions against Nidek (Nagoya, Japan) and VISX (Santa Clara, CA). Verne Sharma, Summit president and CEO, says, "Successfully concluding these kinds of matters is in Summit's interest and in the best interest of the industry."

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