Harnessing the power of light: LASERS IN MODERN MEDICINE AND SURGERY

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In modern medicine and surgery, technological advancements continually push the boundaries of what is possible. One such innovation that has revolutionised various medical procedures is the laser. From precise surgeries to targeted therapies, lasers have become indispensable tools in the hands of healthcare professionals. This article explores the multifaceted applications of lasers in medicine and surgery, highlighting their efficacy, safety, and potential for ongoing innovation.

Understanding laser technology

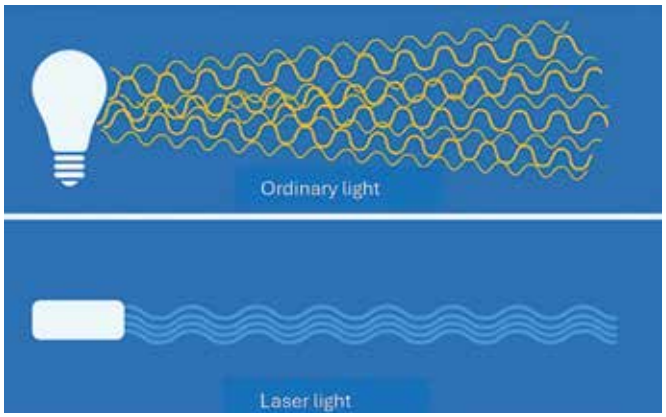
Before delving into the diverse applications of laser technology, it is essential to grasp the fundamentals principles of laser technology. Unlike conventional light sources, lasers emit coherent light, where the light waves are aligned and synchronised. This coherence enables lasers to deliver highly focused energy to specific tissues, facilitating precise interventions with minimal collateral damage to the surrounding areas.

There are two fundamental categories of lasers, namely: continuous-wave (CW) lasers and pulsed (P) lasers. One of the main differences between the two is their power output. Continuous-wave lasers emit a steady stream of light at a constant power level, while pulsed lasers emit light in bursts with high peak powers and lower average powers. CW lasers are often used for applications that require stable laser light such as during a small intestine laparoscopic resection.

In some surgeries, lasers have replaced surgical instruments such as scalpels. Three common lasers that are used in surgery as surgical tool replacements are:

- **Argon lasers**: These are used in the activation of medicine or chemicals within superficial layers of skin and tissues.
- **Carbon dioxide (CO_2) lasers**: These are used to remove thin layers of tissue from the surfaces of the skin. These lasers are commonly used for removing precancerous skin cancer cells, warts, wrinkles, and moles.
- **Neodymium-doped yttrium aluminum garnet (Nd: YAG) lasers**: These are used to penetrate deep within tissues and cells. They mainly function in causing the blood to clot quickly during intensive surgeries. For this type of laser, the laser beam/light is normally inside an optical fibre so that the laser can reach inaccessible areas within the body.

FUN FACT: "Laser beams can be in gas or chemical or solid states".



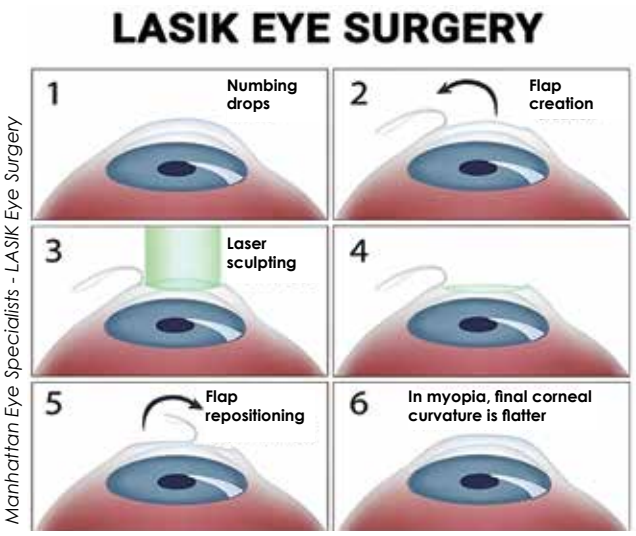
NATO Association of Canada

Figure 1: Laser light waves compared with ordinary light.

This article presents some general applications of lasers in medicine and surgery. It is important to clarify that these general uses do not pertain to lasers replacing surgical instruments or tools. Rather, they involve leveraging the fundamental properties and capabilities of lasers to enhance medical and surgical procedures.

In ***Dermatology,*** lasers are extensively used for various cosmetic and medical treatments. They are employed in procedures such as skin resurfacing for scar reduction and wrinkle removal, tattoo removal by breaking down tattoo ink particles, hair removal by targeting hair follicles, and treatment of vascular lesions like spider veins and birthmarks. In contrast, lasers in ***Ophthalmology*** are crucial in vision correction and treating various eye conditions. Typical uses include LASIK – Laser-Assisted *in-situ* (Keratomileusis)- surgery for refractive error correction, photocoagulation to seal leaking blood vessels in conditions like diabetic retinopathy and age-related macular degeneration, and laser iridotomy for glaucoma treatment by creating a small hole in the iris to improve fluid drainage.

In addition, laser uses in ***Oncology*** are utilised in cancer treatment for surgical procedures and therapies. They are employed in surgery to remove tumours with precision, particularly in delicate areas. In photodynamic therapy (PDT), lasers activate light-sensitive drugs to destroy cancer cells, and laser ablation is used for localised tumour destruction in conditions like liver cancer. In ***General Surgery,*** lasers offer several advantages over traditional techniques, including precision. Lasers can precisely target specific tissues while minimizing damage to surrounding healthy tissue, making them ideal for delicate surgeries and procedures that require minimal bodily invasion. Lasers enable surgeons to perform minimally invasive surgeries through small incisions, resulting in shorter recovery times and reduced risk of complications and haemostasis. Lasers can cauterize blood vessels, reducing bleeding and improving surgeon visibility. Cosmetic surgery utilises lasers for skin rejuvenation, scar revision, and removal of skin lesions to name a few.



Manhattan Eye Specialists - LASIK Eye Surgery

Figure 2: LASIK eye surgery.

In ***Dentistry***, lasers have numerous applications, such as cavity detection and removal with minimal damage to surrounding tooth structure, gum disease treatment through laser-assisted periodontal therapy, Teeth whitening by activating bleaching agents with laser energy, oral surgery procedures such as gum reshaping and biopsy. In addition, lasers can be used for ***Pain Management,*** in the form of low-level laser therapy (LLLT) or cold laser therapy, tissue repair in conditions such as musculoskeletal pain, including arthritis, tendonitis, and back pain, as well as in ***Wound healing*** for chronic ulcers, post-operative incisions and neuropathic pain conditions like diabetic neuropathy and fibromyalgia.

In conclusion, integrating lasers into medicine and surgery has transformed healthcare practices, enabling safer, more precise interventions across a wide range of medical specialties. From cosmetic procedures to life-saving surgeries, lasers continue to play an integral role in improving patient outcomes and quality of life. As technology advances and our understanding of laser-tissue interactions deepens, the potential for innovation and discovery in this field is boundless, promising a future where lasers continue to push the boundaries of what is possible in healthcare.

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