The laser (Light Amplification by Stimulated Emission of Radiation) has been used in Otolaryngology for over 20 years and is by now an accepted part of the armamentarium. A tremendous amount of work is being done in refining existing techniques and developing new ones, and this review discusses some of the recent advances.

**KEY WORDS**
Laser, Otolaryngology, Review.

**INTRODUCTION**

The laser (Light Amplification by Stimulated Emission of Radiation) has been used in Otolaryngology for over 20 years and is by now an accepted part of the armamentarium. A tremendous amount of work is being done in refining existing techniques and developing new ones, and this review discusses some of the recent advances.

**BASIC PRINCIPLES**

The basic elements of a laser are a lasing medium, an energy source and an optical cavity. The energy is used to elevate the atomic particles of the medium to higher energy states. This situation is called population inversion and acts as a continual source of photons. The excited particles then return to their normal state with the emission of energy in the form of a photon, the wavelength of which is determined by the characteristics of the lasing medium. As the photon encounters another excited element, it stimulates the release of another photon of the same wavelength, travelling in the same direction and in phase, and in this way the light is amplified. The optical cavity containing the lasing medium has a 100% reflective mirror at one end and a semi-reflective mirror at the other end. The photons travelling along the axis of the mirrors are reflected and thus continue travelling within the optical cavity and stimulating the release of more photons. Photons not travelling along the axis of the mirrors are not repeatedly reflected and are thus not amplified. This reflection produces a temporally and spatially coherent beam of light which escapes via the semi-reflective mirror as the laser beam.

The first lasing medium used was a ruby, but now a number of lasing materials are available, including gas (CO₂, Argon), liquid (the dye lasers), solid (Neodymium : Yttrium Aluminium Garnet and semiconductor diodes) and free electron lasers. Various excitation methods are employed and the laser may be used in continuous wave or various pulsed mode.

**TISSUE INTERACTIONS**

Laser light falling on tissues may be reflected, scattered, transmitted or absorbed. Only the absorbed light causes a tissue reaction. The main substance absorbing the laser is called the primary chromophore. Absorption produces mainly kinetic excitation of the absorbing molecules. Kinetic excitation produces thermal effects ranging from reversible hyperthermia through enzyme deactivation, protein denaturation and coagulation to dehydration, vaporization and carbonization.

**USE OF LASERS**

Lasers should be used when they offer a definite
advantage over conventional techniques. These advantages may include better haemostasis, improved access to confined areas, improved precision, repeatability, and safety. Lasers in widespread use in Otolaryngology include the CO₂, Argon and KTP/532 laser.

The CO₂ laser has a wavelength of 10.6 μm, in the far infrared. Its main chromophore is water and therefore it has a superficial mode of action, with predictable limited depth of penetration, which makes it a good ablator of tissues. It is however only moderately haemostatic, and commercial fibre-optic transmission is not available although prototype silver halide fibres are being developed.

The Argon laser has a variable wavelength from 488-514 nm. It has an unpredictable depth of penetration which is affected by the presence of char. Its main chromophore is haemoglobin which makes it useful in vascular areas, but it produces greater thermal damage and thus care must be taken to avoid damage to adjacent structures. The beam can be passed down a flexible optical fibre.

The KTP/532 laser has a visible green beam which acts as its own aiming device. It can be used for cutting, coagulation and vaporization, and the beam can be delivered via an optical fibre. Its main chromophore is also haemoglobin.

Mid-infrared lasers are now becoming commercially available. They are based on the YAG crystal which is doped with differing elements that vary the wavelength from approximately 1-3 microns. The advantages of these wavelengths are that they are primarily absorbed by water and are also excellent for bone work. Their high coefficient of absorption and pulsed delivery results in precise tissue ablation and minimal thermal damage.

The main uses of lasers can be divided into therapeutic and diagnostic.

**THERAPEUTIC**

Lasers have been successfully used endoscopically for ablating tumours in the respiratory and digestive tract. Other minimally invasive techniques include interstitial laser fibreoptic treatment of head and neck tumours. With the advent of high-speed Magnetic Resonance Imaging, MR guided needle placement for interstitial laser therapy promises further advances.

The haemostatic properties of lasers have led to their use in Endonasal Sinus Surgery, where many of the complications are caused by bleeding which limit visibility. The ideal laser for endoscopic sinus surgery should have good haemostasis, good tissue coagulation and ablation, good bone ablation, fibreoptic delivery and the ability to be used in a “wet” field. The CO₂ laser beam has been used endonanally but the beam cannot be delivered via a fibreoptic system, the laser energy is absorbed by blood and water, and the bone interaction is poor. More recently, the CO₂ laser beam has been delivered down a “waveguide” but this is still rather unwieldy. The Argon and KTP/532 lasers have also been used, with good surface coagulation of tissue and the ability to pass the beam down a flexible optical fibre, but again bone interaction is poor and soft tissue interaction limited. The Nd:YAG laser can be used intranasally with a contract probe delivery system. Shapshay et al have investigated the in-vitro properties of the Holmium:YAG laser and report good haemostasis, soft tissue and bone ablation. Further evaluation in a clinical setting is under way.

Helidonis et al have used the CO₂ laser to alter the shape of human nasal septal cartilage without carbonization or ablation of the tissue, and examined the histological changes. This may be beneficial for shaping cartilage grafts, and if the technique can be modified for in vivo use, could have implications for operations such as septorhinoplasty.

Lasers have been used in the treatment of recurrent respiratory papillomatosis, where medical treatments have proved unsuccessful, and the mainstay of treatment has been surgical...