

A REVIEW OF THE USES OF LASER IN GASTRO-INTESTINAL TRACT

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LASER (Light Amplification by Stimulated Emission of Radiation), is a mechanism of emitting electromagnetic radiation typically light as a process of stimulated emission.

Common light sources (electric light bulb) → Emit photons in all directions, usually over a wide spectrum of wavelengths. Most light sources are incoherent

LASER → Emit photons in a narrow, well defined beam of light. The light is often near-monochromatic, consistency of single narrow wavelength. It is highly coherent and is often polarized.

LASER was introduced to practice in 16 May 1960^{1,2}. Laser introduced into medicine at early 1970¹¹.

LASER in Medicine: various types of laser are used in medicine for diagnosis, treatment and therapy.

The medical areas that employ laser include: Angioplasty, Dentistry, Dermatology, Lithotripsy, Mammography, Ophthalmology, Surgery, Urology, Cancer laser (PDT: Photodynamic therapy)³.

Introduction

Laser was introduced to gastroenterology in early 1970s for arresting G.I bleeding but later, the laser light was used as a diagnostic tool.

Due to advances in G.I endoscopic in both upper and lower G.I tracts and because of the advances in production of light of many wavelengths & intensities that can be transmitted through small diameter fibers and these fibers can be readily inserted through the instrument channel of endoscope. These make a revolution in management and later the diagnosis of many gastrointestinal disorders during the last 40 year. This article reviews the uses of laser in gastroenterology.

Therapeutic uses of laser

Tumor ablation:

There are 2 ways for tumor ablation by lasers ; *The thermal method* → the most common way. It is done by converting laser light to heat to vaporize tissue. *Photodynamic therapy* method: that to use light to activate a previously administered drug and convert it into a cytotoxic compound which lead to tumor necrosis.

The aim in both methods is to reduce tumor size and relief obstruction caused by the tumor in bowel or ducts of the G.I.T such as palliative treatment of esophageal cancer, obstructive lesion of large intestine and C.B.D⁴.

Thermal methods: to vaporize the tumors. Many lasers can be used for this methods, such as Nd:YAG laser

In esophageal Ca:

Endoscopic laser therapy can be used initially before surgery or can be used after failure of surgery by 2 ways:

contact and noncontact methods⁵. It is used to establish an adequate lumen in esophagus and improve dysphagia. This method gives poor result if the tumor is more than 5cm in size or at esophago-gastric junction⁶. The complication of this method is perforation, trachea-esophageal fistula, bleeding and odynophagia⁵.

Large intestine tumor:

Laser is used for those patients who are inoperable or have operation risks and result. So patients with obstruction, bleeding, or huge mucus discharge might benefit from endoscopic laser therapy⁷.

Photodynamic therapy (PDT)

It has been used to treat variety of tumors within gastrointestinal tract by using various photo sensitizers such as photofrin, ALA (5-amino laevulinic acid), mTHPC (mesotetrahydroxyphenyl chlorine)

There are 2 methods:

Intra-luminal illumination: by using cylindrical tip placed within residual lumen of the tumor and tumor is irradiated from luminal aspect.

Interstitial method: a laser is placed in direct contact with the tumor or within the tumor parenchyma itself. It is used in the following: Esophageal cancer: Is palliative method in advance esophageal cancer, but also curative method in early esophageal cancer⁸. Stomach Ca: Can be used in patients with poor operative risks and those refuse surgery⁹. Colorectal cancer: Used in inoperable colorectal tumor. To relieve obstructive symptoms, bleeding, mucous discharge¹⁰. Biliary Tree: Especially in cholangio Ca of CBD.

Bleeding:

Ulcers: The use of lasers to stop G.I. bleeding was attempted in early 1970. Both the argon and Nd:YAG lasers have been used to stop bleeding from

peptic ulcers. Nd:YAG laser proved to be superior to Argon one¹¹.

The Nd:YAG laser is delivered to the ulcer through quartz fiber in a noncontact method. Several applications are required to the ulcer bed in the area of the bleeding point. So the result depend on the type of bleeding ulcer according to Forrest classification on the duration of the procedure¹².

The complications of laser photocoagulation are perforation and sometimes aggravation of bleeding.

Vascular malformation:

There are numerous types of vascular malformations within G.I.T causing bleeding but the most important are: Angiodysplasia Malformation associated with hereditary telangiectasia. Both can be treated by argon and Nd:YAG laser.

Argon Laser: produce blue-green wavelength. Is absorbed by the hemoglobin of their vascular lesions by shallow penetration. The risk of perforation is low¹³. Nd:YAG laser: penetration of tissue is greater than argon laser. Therefore, it is more effective and there is more risk of perforation.

Angiodysplasia bleeding response better than bleeding of hereditary telangiectasia¹³

Other vascular lesions:

Watermelon stomach bleeding is treated by argon and Nd:YAG laser and both are effective

Radiation hemorrhage in recto sigmoid junction can also be treated by laser photocoagulation¹⁴.

Interstitial laser coagulation

Laser induces thermal necrosis and used to coagulate metastasize within solid organs particularly the liver¹⁵. Laser energy is typically delivered by one or more laser fibers placed directly into metastatic lesion. Lesion less than 4cm can be treated by Nd:YAG laser¹⁶.

Lithotripsy

Laser waves can fragment the biliary calculi and used in CBD stone fragmentation.

We can use average pulse duration laser to fragment the stone because the long pulse duration lead to melting of the stone rather than fragmentation .To perform that, laser fiber must be in direct contact to the stone. The procedure is performed in an aqueous environment, this result is better¹⁷.

This procedure can be perform by choledochoscope inserted through ERCP.

Diagnostic uses of lasers:

Most laser application in gastroenterology depends on the light to alter the tissue and thereby produces therapeutic effect.

Now in recent years, the laser is used as diagnostic devices by using the light in probing and non destructive fashion to get information for diagnosis. So, diffuse reflection spectroscopy and fluorescence spectroscopy is used to distinguish the benign from malignant lesion.

Laser induced fluorescence:

Fluorescence spectroscopy is used in physics and chemistry to analyze the materials. To analogue the tissue we must used pulsed nitrogen laser or helium laser as sources of excited light, so this light is transmitted through small fibers passed through endoscope and the induced fluorescence is captured by the same fibers and transmitted back to the analyzer¹⁸. So laser induce auto-fluorescence is a valuable mean of determining tissue types and metabolic state of the tissue¹⁹. There are many problems in G.I.T that can be approached by this methods for diagnosis such as polyp typing, identifying dysplasia, and neoplasia²⁰.

Confocal laser endoscopy now used for 1. Early diagnosis of G.I.T

malignancy^{21,22}. 2. Diagnosis of H.pylori by OGDS²³. 3. To differentiate between hyperplastic and adenomatous polyp²⁴.

Future of laser in G.I.T

By development of new laser sources and new delivery device, new photosensitizing drugs. We can improve and make advance of laser in gastroenterology.

To destroy small tumors deposits that are not visible to the naked eye or which involve areas than cannot be resected. Application of PDT for treatment of H. pylori especially with increase resistance of H. pylori to antibiotics therapy using as methylene blue as photo-sensitizer to use in fluorescence endoscopy for diagnosis of early malignant lesions in Barrett's esophagus or in chronic ulcerative colitis to use PDT in the management of pancreatic and unresectable cholangio Ca. by introduction of laser light through needles inserted percutaneous under US or CT guidance to tumor area using mTHPC as photosensitization drug²⁵.

Conclusion

The uses of laser in gastroenterology can be summarized as; Thermal Laser: High power laser: is used in endoscopic palliative management of G.I.T cancer and also for coagulation of bleeding lesion and ulcer. Low power laser: (interstitial laser photocoagulation) used in management of isolated hepatic metastasis. Photodynamic therapy: non-thermal destruction of the tissue by activation of photosensitizing drugs and used in management of small inoperable tumor of G.I.T.

Pulsed Shock wave: used for fragmentation of gall stones Light boned optical method: used for diagnosis of lesion in the gut and give more accurate and faster diagnosis.

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