# CONTENTS

## VOLUME 16 NUMBER 1  
March 2007

### Editorial

**LASER THERAPY IS ON THE MARCH!**  
Toshio Ohshiro MD PhD .................................................. 5

### Original Articles

**A NEW APPROACH TO ULCER TREATMENT USING BROADBAND VISIBLE LIGHT**  
Rachel Lubart, Zvi Landau, Julia Jacobi and Harry Friedmann ................................. 7

**MODIFIED PHOTODYNAMIC THERAPY FOR GASTROINTESTINAL CANCERS**  
Tetsuya Nakamura, Takeshi Oinuma, Katsuro Shirakawa, Hidetsugu Yamagishi,  
Hirokazu Fukui, Takahiro Fujimori, Hideyuki Hiraishi, and Akira Terano ................. 11

**APPLICATION OF DIODE PUMPED ND:YAG LASER FOR ALLERGIC RHINITIS**  
Shunji Fujii, Toshio Ohshiro, Takaumi Ohshiro, Katsumi Sasaki, and Yuki Taniguchi .... 17

### Review Article

**THE CO₂ LASER AS A VERSATILE SURGICAL MODALITY**  
Isaac Kaplan ................................................................. 25

### Memorial Article

**NEW THERAPEUTICAL EFFECTS OF LOW LEVEL LASERS AND CLINICAL APPLICATION IN DENTAL AND ORAL SURGERY**  
Akinori Nagasawa and Kazuichi Kato ........................................ 39

**CALENDAR OF LASER CONGRESSES** .................................. 47

### Publish Agreement ..................................................... 54

### Notes for Contributors .................................................. 55

### Join IPTA!! ................................................................. 57

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**OFFICIAL JOURNAL OF THE INTERNATIONAL PHOTOTHERAPY ASSOCIATION**

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OVERVIEW OF JOURNAL CONTENTS

Original articles:
The Editors invite the contribution of relevant original research papers of a scientific or clinical nature, and clinical reports, which have not appeared in any other publication. In addition, from time to time, the Editors may request an author or authors to produce comprehensive review papers. Unsolicited review papers will be returned to the author.

Company profiles:
An up-to-the-moment report on manufacturers with new laser and related products which will be of interest to readers of the journal. Manufacturers are invited to submit material for this section to the Publishing Coordinator.

Profiles:
A profile of one of the leaders in the field of laser therapy, who may either be a clinician, a researcher, or a combination of both.

Book reviews:
New books will be reviewed by an expert in the field. Reading copies are invited from authors and publishers.

Meeting calendar:
A calendar of forthcoming LLLT-related events and happenings will be compiled on an international basis. (Congress, course and meetings organizers are invited to send details of their events to the Publishing coordinator).

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The rapid increase over the last two decades in the use of low reactive-level laser therapy (LLLT) and its acceptance in many branches of medicine and allied disciplines, followed by the new interest in other non-laser phototherapeutic sources such as light-emitting diodes (LEDs), has led to the need for an international forum for the exchange of ideas and information, dedicated to all aspects of pure phototherapy and photobiomodulation.

From its inception in 1988, Laser Therapy was the first journal to link an international outlook in the field of phototherapy with high standards of academic content, and remains the only journal dedicated to this concept. Clinical and basic scientific studies in the use of low reactive-level laser therapy (LLLT), phototherapy, photodynamic therapy (PDT) and related research into photobiomodulation will be considered for publication.

The primary aim of this journal will be to publish original research papers of the highest quality; particular attention will be paid to the design of experiments, including detailed reporting of all parameters used, and meaningful analysis of results.

- All original papers submitted will be refereed by independent experts in the field.
- Regular review articles designed to bring the general reader up to date in the use of phototherapy with lasers and other sources in various areas will be a feature of the journal. Please note that review papers will be invited by the Editor-in-Chief. Unsolicited review papers will be returned.
- Anecdotal reports will only be accepted if, in the view of the Editors, they are correctly reported as far as parameters and methods are concerned, and if publication will prove useful to the readership in reporting a previously unknown aspect of laser therapy or will act as a stimulus to further research.
- An occasional Product Review section will give details of new light-based therapeutic equipment and publications on the market.
- Correspondence to the Editors on any aspect of phototherapy is encouraged. If parameters are given, please make sure they are given in full.
- The Editors reserve the right to make alterations in the text of contributions, without altering the technical context, when considered desirable in order to produce either conformity of style or because of space limitations.

IMPORTANT NOTE:

Authors: please refer to and follow the ‘NOTES FOR CONTRIBUTORS’ when preparing manuscripts, paying particular attention to the style for the references. Manuscripts not adhering to the journal style will be returned unreviewed.
Dear Laser Therapy readers, welcome to this first issue of Volume 16. With this issue, you can truly see that Laser Therapy is on the march! This is really a ‘first’, not just of the current volume, but as proof of our plans to continue the expansion of Laser Therapy, and to show how serious we are about making the journal even more informative and even more serious about our commitment to act as the best forum for the phototherapy community. For the first time since its inception in 1988, with the exception of a very few special editions produced as companion journals for WALT meetings, and the Second Pilot Issue which I commissioned as the first stage of the rebirth of the journal, Laser Therapy is 60 pages long!

We do not intend to stop there, however: we would like to see it even longer. We cannot do this alone, and even this 60-page issue has been realized through the efforts of the authors who have submitted papers for publication. Without papers, there can be no journal, so please, all of you working anywhere in the phototherapy field, this is YOUR journal … please support it by putting pen to paper, or more likely fingers to keyboards, and tell us what you are doing, what you have discovered, what works, and perhaps even more importantly, what doesn’t. The journal will accept papers on any aspect of phototherapy and photobiomodulation, even those of a purely clinical nature, from any researcher, clinical or paramedical professional working in the field, including a warm welcome to articles from the physical therapy community.

As I have said before, the only thing that I ask (and the reviewers demand) is careful, complete and concise reporting of the parameters you are using. Please give them all, so that your work can be replicated from the point of view of scientific veracity, or simply as an excellent guide for others who are learning or just starting out on the research or practical clinical aspects of phototherapy. Tell us what system you are using, giving the manufacturer’s name and model number, with the city and country where the manufacturers are based. Tell us what the system is: for example, a quasimonochromatic light-emitting diode (LED) array-based system, a polarized polychromatic light source delivering visible red to near infrared light, or an infrared laser diode-based system. Give us the wavelength or waveband in nanometers. Tell us what the output power is, in watts (W) or appropriate subunit such as milliwatts (mW), incident at the target tissue or specimen. Please get this measured yourselves, using appropriate power meters, and do not just state what the manufacturers claim. State the area you are irradiating per single irradiation, in square centimeters (cm²). This will then give the incident power density, or irradiance, in W/cm². How long is each irradiation, in seconds? With that information, we can then work out the incident energy density, or dose, also known as the radiant flux, expressed in joules per square centimeter (J/cm²). Do you treat a large area in one single shot, or do you treat point by point? Tell us how long each treatment session is, and how many sessions are given for a treatment course. All of this information is critical in allowing others to achieve the same effects that you are. For researchers, the above physical data are also essential, as are your experimental conditions in detail, including precise descriptions of whatever medium is being used, if any; are you irradiating under a carbon dioxide atmosphere; what sort of plates you are using with the cell count per well; is the specimen being agitated constantly; and so on. The more detailed you are, for both clinical and basic experimental papers, and even for purely anecdotal papers, the more chance you have of getting your papers published in the journal. Many papers are returned, even with excellent results, because the parameters are incompletely reported. We look forward to hearing from you!

As you all know, the first meeting of the International Phototherapy Association (IPTA) was held successfully in Suwa City, Nagano Prefecture, Japan, last July, and the second meeting is planned for April 2008 in New Zealand under the very able presidency of Professor David Baxter of Otago University, no stranger to the field of phototherapy. IPTA was formed by a group of professionals who were extremely worried about the way the World Association for
Laser Therapy (WALT) was progressing after the 2004 meeting in Brazil. Democracy had always been the keystone of WALT, and the International Laser Therapy Association (ILTA) before it, of which I was the Founding President, so the very undemocratic way in which the very serious issues of the General Assembly were approached at the Brazil meeting sent out warnings regarding the seriousness of WALT as the organization representing laser therapy in both clinical and experimental fields. However, The 6th international congress of WALT was very successfully held in Lemesos, Cyprus, October 25-28, 2006, and was an excellently-managed and truly democratic meeting in the mold of previous WALT meetings. Laser Therapy would like sincerely to congratulate Prof Farouk al-Watban, WALT President, and his Executive Committee on successfully holding the 2006 WALT meeting in the spirit of true democracy and good science. This has reassured us all that WALT is still an excellent body, and IPTA will hold its meetings in odd years after the 2nd meeting so as not to dilute attendance at either meeting. The only reason the 2nd IPTA meeting will be held in 2008 and not this year is simply the time required to put a meeting together. The 3rd meeting is now actively being planned for 2009.

IPTA was not formed as a competitor to WALT, but as a more specialized group providing a forum for all aspects of phototherapy and photobiomodulation. It is the earnest hope of the current IPTA President, Yoshimi Asagai MD and the IPTA Executive, that WALT and IPTA should coexist in harmony, not as competitors but as sister societies, so that knowledge in the field of phototherapy, laser therapy and photobiomodulation will be accurately and widely disseminated.

On another phototherapy front, the Japan Society for Laser Reproduction (JaSLaR) held a very successful meeting on Sunday, March 4th 2007. 106 attendees heard 20 presentations, including special guest lectures, invited symposia speakers, educational lectures and clinical updates in the field of laser therapy-assisted fertilization at the New Hospital Wing, in the School of Medicine of Tokyo's prestigious Keio University. JaSLaR was officially founded, and I had the honor and pleasure of being elected as JaSLaR President. The use of laser therapy in female infertility was covered in Volume 15 of the journal, and I am certain we shall see more on this exciting topic in future issues. Laser Therapy was decided to be official journal of JaSLaR.

Finally, it is my great pleasure to inform you that we have submitted Laser Therapy for consideration by the United States National Library of Medicine for listing and indexing in Medline. I have every hope that our application will be successful, and this will be an enormous step forward for the journal. In the meantime, I have to report that the Japan Medical Laser Laboratory (JMLL) will become as the journal's publishers, although we have been exploring the possibility of a professional publishing group taking the journal over. However, for the moment we feel it is in the best interests of the journal, and of our IPTA whom we have the honor of representing as their official journal, that the present publishing status quo should be maintained. If this changes, you, our faithful readers, will be the first to know.

May I wish you all a very happy and prosperous 2007, the Year of the Boar in our Oriental 12-animal zodiac. Please, get writing, and remember Laser Therapy as your first journal of choice for articles on any aspect of phototherapy and photobiomodulation. Together, let us elevate the journal to even higher levels of excellence! Toshio Ohshiro

Tokyo, March 2007
Introduction

Phototherapy, the use of light for healing, has been a field of advanced multidisciplinary research for the last few years. This modality, as demonstrated in the use of laser light and LED (light emitting diode) technology, has been shown to be beneficial in a wide and diverse array of maladies, including the healing of chronic and acute wounds.(1)

The stimulatory effects of low energy laser (LEL) irradiation on cell activation have been largely demonstrated in vitro in a variety of cell lines. For example, LEL has been found to stimulate the release of transforming growth factor-b (TGF-b) and platelet-derived growth factor (PDGF) from cultured fibroblasts.(2) Studies with fibroblasts and keratinocytes indicate that at specified relatively low energy doses of HeNe laser or 780 nm diode laser, accelerated mitosis occurs. (3) Recently green-yellow light (570 nm) was found to enhance fibroblast growth impaired by a high glucose level.(4)

Animal studies on the enhanced wound healing effect of laser light at low power density have been performed on toads, mice, rats, guinea pigs, and swine.(5,6) Human studies with laser light have demonstrated greater amounts of epithelialization for wound closure and stimulation of skin graft healing.(7,8) Recently, Whelan et al.(9) reported a 50% faster healing of wounds treated with a LED array with 3 wavelengths combined in a single unit (670nm, 720nm, 880 nm). It is known that visible and near IR light can be absorbed by cellular photosensitizers such as cytochromes, flavins/riboflavins and NADP.(10) Absorption of light by these photosensitizers causes their excitation and relaxation by transferring electrons to O₂, thereby generating reactive oxygen species (ROS). Recent evidence has demonstrated that low ROS fluxes play an important role in the activation and control of many cellular processes, such as transcription factor release, gene expression, muscle contraction and cell growth.(11,12) In a very recent work by the authors,(13) we tried to identify the endogenous photosensitizers responsible for ROS production by visible light. We used electron paramagnetic resonance (EPR) coupled with the probe trapping technique, to monitor oxyradicals produced in various cell cultures as a function of the wavelength illuminating them. We found that oxyradicals were created mainly by the flavins at the 400-500 nm visible light waveband. Wavelengths above 500 nm probably stimulate the cell by accelerat-

A NEW APPROACH TO ULCER TREATMENT USING BROADBAND VISIBLE LIGHT

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Conventional therapy-resistant chronic ulcers have been treated recently with low energy lasers or light emitting diodes in the visible and near IR region. In the present work, we studied ulcer healing using broadband (400-800 nm) visible light. Twenty patients suffering from diabetic and venous ulcers were irradiated with broadband (400-800 nm, 40 mW/cm²) visible light. Each ulcer was irradiated for 5 minutes three times a day. Success was defined as the complete healing of the ulcer. A complete cure was observed in 70% of the patients. The duration of the therapy was 8-12 weeks. The new broadband visible light source seems to have a strong effect on the complete healing of ulcers.

Key words: Phototherapy, broadband visible light, chronic ulcers

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ing the mitochondrial respiratory electron transfer, as was first suggested by Karu.\(^{(14)}\)

Various devices have been implemented in phototherapy, especially in wound healing. The most prevalent to date are the low level laser therapy systems (~10 mW/cm\(^2\)) and LEDs, which typically produce low energy intensities (10-50 mW/cm\(^2\)) at a band width of around 10 nm. Until recently, broadband light emitting systems, emitting polychromatic light from the visible into the IR spectrum, have been neglected. However, we have shown that broadband visible light, at an appropriate energy dose similar to that produced by LEL, produces ROS, and increases intracellular Ca\(^{++}\) concentration.\(^{(15)}\) Fibroblast proliferation following broadband visible light irradiation has also been also measured.\(^{(16)}\) Based on these findings, because the absorption bands of cytochrome oxidase and flavoproteins are quite wide,\(^{(17)}\) we believe that expensive lasers are not actually needed for their excitation.

Noncoherent (i.e. not laser) polychromatic light sources in the visible range have been shown to be capable of ROS generation and can enhance fibroblast proliferation in the same way and in an equal degree as LEL sources, so based on this we decided to use such a broadband noncoherent phototherapy device for wound healing. In this observational preliminary study, we report on our experience with a broadband visible light device in the treatment of patients with chronic ulcers in whom conventional treatment had previously failed.

### Subjects and Methods

Twenty patients with chronic diabetic or chronic venous ulcers, in whom conventional treatment had failed, were included in this preliminary study. All patients underwent an evaluation that included a complete history, physical and neurological examinations and appropriate blood tests. Conventional treatment was administrated, including topical treatment and pressure bandages in cases of venous ulcers, debridement and oral antibiotics according to wound cultures, and weight off-loading. In the case of diabetic ulcers on the feet, conventional treatment as delineated above was combined with local ulcer care (with various creams, ointments or saline). The phototherapy was performed at home and the patients were seen every week or every other week.

Each patient was irradiated with a 40mW/cm\(^2\) broadband visible light system delivering 400-800 nm, for 5 min, 3 times a day. The emission spectrum of the light source is presented in **Fig. 1**. During each treatment, a dose of 12 J/cm\(^2\) was irradiated at the surface of the ulcer. Conventional treatment was continued during the treatment period. Patients were monitored at least once weekly, and the ulcer appearance was recorded by the same observer. The primary end point was ulcer healing defined as the complete closure of the ulcer.

### Results:

Twenty patients with chronic non-healing ulcers were included in this study. The mean age of this group was 70 ± 5 years. The mean duration of the ulcers before the start of treatment was 3.1 ± 2 months. The mean duration of treatment was 40 ± 10 days. Complete closure of the ulcers was obtained in 14 (70%) of the patients. Examples for complete closure are monitored in **Figs. 2 and 3**.

### Discussion

Diabetic foot (DFU) and chronic venous ulcers (CVU) are cutaneous lesions that are difficult to treat and heal. Conventional therapies, including local treatment/debridement and antibiotics, are frequently ineffective. Even when successful, these treatments result in wound healing that occurs slowly and with a great deal of pain and disability.

LEL provides the stimulation or photobiomodulation of the target tissue, which results in increased cellular activity during wound healing.\(^{(18)}\) In multiple studies conducted by Whelan et al\(^{(9)}\) in collaboration with NASA, LED phototherapy was proven to accelerate wound healing and reduce the pain of pediatric
**Fig. 2:** Before (a) and after (b) broadband visible light treatment.

**Fig. 3:** Before (a) and after (d) broadband visible light treatment.
mucositis. Because we have found that broadband (400-800 nm) light mimics \textit{in vitro} studies performed with LEL or LEDs, we decided to examine the effect of broadband visible light on wound healing. As can be seen in our preliminary study (Figures 1 and 2), the therapeutic effect is apparent in our patients. In 70% of our patients complete closure of the ulcer was observed. Unlike lasers and LEDs in the visible range, which stimulate cell activity at a single wavelength and over a very small area, a broadband of frequencies excites many cellular targets and also enables the coverage of large surfaces, which is a key to large surface applications such as wounds and burns. Note that there are LED arrays to answer this need, but the devices are usually cumbersome and produce a fairly low intensity. The ability to irradiate large areas with relatively high energy contributes to a significantly shorter session time, requiring only 2-5 minutes. Not less important, compared with lasers and LEDs systems, broadband visible light systems are much less expensive, and open the door for home application.

Our impression is that broadband light is a promising technique. Further confirmation must, however, await the performance of prospective randomized controlled studies which are currently ongoing.

References:

Photodynamic therapy (PDT) is based on the theoretical principle: the specific low level laser light irradiation activates a photosensitizer which is selectively concentrated in rapidly proliferating tissues including malignant tumor cells, resulting in selective necrosis by the intracellular singlet oxygen from photochemical reaction. PDT using Photofrin® (porfimer sodium) with excimer-dye laser (EDL) was approved in Japan. Its indication for GI cancers was limited to superficial esophageal and early gastric cancer not indicated for other curative treatments. Meanwhile, endoscopic mucosal resection (EMR) is considered the first choice of treatment for intra-mucosal GI cancers. Thus PDT has been considered as one of the alternative treatments for GI cancers including recurrent cancer; however, its efficacy was relatively limited. Therefore, we have designed a new therapy called "Modified PDT." The major points of Modified PDT are as follows. 1. Irradiation of EDL is applied to the lesion not only 48 but also 72 hours after Photofrin® injection. 2. When the cancer is polypoid type, partial resection of the cancer is performed before irradiation. 3. Before the second irradiation, necrotic tissue covering the surface of the lesion is removed. Modified PDT was carried out on 20 patients (mean age 73 years). Complete response was achieved in 4 of 6 (66.7%) of superficial esophageal cancers, 9 of 10 (90%) of early gastric cancers, 1 of 3 (33.3%) of advanced gastric cancers and 1 rectal cancer. No serious complication occurred. Modified PDT may be considered an alternative therapy for GI cancers not indicated for EMR or surgery.

Key words: Modified photodynamic therapy (PDT), superficial esophageal cancer, early gastric cancer, rectal cancer
tizer in 1994. However, its indication for GI cancers was limited to superficial esophageal and early gastric cancer which was not indicated for surgical operation.

In almost the same period, endoscopic mucosal resection (EMR) has developed for curative treatment of intra-mucosal GI cancers (esophageal, gastric and colon) and it is considered the first choice of treatment in Japan. Thus PDT has been considered as one of the alternative treatments for GI cancers not indicated EMR including recurrent cancer; however, its efficacy was relatively limited. Therefore, we have designed a new therapy called “Modified PDT” to treat GI cancers not indicated for EMR or surgery.

**Procedures and Principles of PDT using Photofrin® in Japan**

Photofrin® (2mg per kg) is injected intravenously to the patient suffering from superficial esophageal and/or early gastric cancer. After injection of Photofrin®, it is cleared from most tissues in 40 to 72 hours but retained for longer periods in cancer cells, skin, and the reticuloendothelial system. Hence light application is usually scheduled at 40 to 50 hours after injection. At that time, low level laser light of EDL (630nm, 4mj output, 40Hz) is irradiated to the target lesion including cancer through bare quartz fibers endoscopically. Total light doses of 60 to 100 J/cm² are used for superficial esophageal cancer and early gastric cancer. Upon light exposure, the production of singlet oxygen and other reactive chemical radicals cause local non-thermal cellular damage, vascular thrombosis, and necrosis, which evolve over hours to several days. Even if there is damage to healthy tissues, that is healed by regeneration. Therefore, the cancer and its surrounding healthy tissue can be treated without surgery. And treated areas are safely healed without risk of perforation and intense bleeding. On the other hand, cutaneous photosensitivity occurs in the patient because Photofrin® is retained for longer periods in skin. Thus avoidance of exposure to bright light or direct sunlight is needed for the patient for at least 30 days and often up to 90 days.

**Materials and Methods**

**Patients**

Between November 2002 and September 2005, Modified PDT was carried out on 20 patients (mean age 73 years, range 55 to 87) suffering from GI cancers (6 superficial esophageal, 10 early gastric, 3 advanced gastric and 1 rectal) who were not indicated for surgical operation or EMR. Written informed consent was obtained from all patients.

**Methods of Modified PDT**

The major points of Modified PDT are as follows.

1. Irradiation of EDL (630nm, 4mj output, 60-80Hz) is applied to the cancerous lesion and its surrounding mucosa not only 48 (Day 1) but also 72 hours (Day 2) after Photofrin® (2mg per kg) injection. Target light dose is 60-100 J/cm².

2. When the cancer is polypoid type, partial resection of the cancer is performed before irradiation.

3. Before the second irradiation on Day 2, necrotic tissue covering the surface of the cancerous lesion is removed by biopsy forceps. Target light dose of the second irradiation is less than 60 J/cm².

According to the shape and/or location of the cancerous lesion, cylindrical type of quartz fiber was applied for contact laser irradiation. For the treatment of superficial esophageal cancer, transparent food was used to obtain precise laser irradiation.

Admission period of Modified PDT patient was set at 2 weeks and avoidance of exposure to bright light or direct sunlight was demanded for the patient for at least 4 weeks after discharge.

**Evaluation of Efficacy**

Follow-up endoscopic examinations were carried out at 1 week, 3 months (M) and 6M after irradiations of EDL. Evaluation of the efficacy of Modified PDT was performed at the 3M follow-up period. Complete response (CR) was defined as: there was no evidence of residual and/or recurrent cancer cells by endoscopic observation and biopsy. Partial response (PR) was defined as: there was some evidence of residual and/or recurrent cancer. No change (NC) was defined as: there was no response for cancers by Modified PDT or rapid growth of recurrent cancer the same as the cancerous lesion before treatment.

**Results**

The efficacy results of Modified PDT for GI cancers are shown in Table 1. In 6 esophageal cancer patients, 5 of them were squamous cell carcinoma histologically including two recurrent patients after chemoradiotherapy. There were 7 squamous cell carcinoma lesions and 6 of them (85.7%) disappeared completely by single course of Modified PDT. The other esophageal cancer patient
had 3 adenocarcinomas arising from Barrett’s esophagus including 2 polypoid lesions. One flat lesion disappeared completely and 2 polypoid lesions decreased by single course of Modified PDT. Finally, 4 of 6 patients (66.7%) with superficial esophageal cancers were considered CR.

In 10 early gastric cancer patients, 3 were recurrent after EMR. There were 13 adenocarcinoma lesions including 4 poorly differentiated type and 11 of them (84.6%) disappeared completely by single course of Modified PDT. Repeated Modified PDT was carried out for 2 remnant cancerous lesions; one of them disappeared completely but the other lesion remained in the patient who had 3 poorly differentiated adenocarcinoma lesions. Finally 9 of 10 patients (90%) with early gastric cancers were considered CR.

In 3 advanced gastric cancer patients, 2 of them had single lesion (T2 (tumor invades muscularis propria), N0 (no metastasis)) and the other patient had 3 lesions including 2 early gastric cancers. By single course of Modified PDT, 2 early gastric cancer lesions and one advanced gastric cancer lesion in another patient disappeared completely; however, 2 advanced gastric cancer lesions remained histologically. Finally, one of 3 patients (33.3%) with advanced gastric cancers (T2 (tumor invades muscularis propria), N0 (no metastasis)) were considered CR.

Concerning rectal cancer patient, there was a polypoid lesion recurrent after EMR in the lower portion of rectum. Several times of piecemeal polypectomy were performed before Modified PDT, and the cancerous lesion disappeared completely after 30 M follow-up period. This patient was considered CR.

No patient died of recurrent GI cancers during 10 to 44M follow-up period. Slight sunburn in the face and/or the limbs occurred in 4 patients (20%) but they recovered. No serious side effect occurred.

**Case 1, 62 year-old man, recurrent esophageal squamous cell cancer after chemoradiotherapy**

In August, 1999, endoscopic examination revealed squamous cell carcinoma in the middle portion of the esophagus (Fig. 1). Chemoradiotherapy was carried out because he was not indicated for surgery by liver cirrhosis. Squamous cell carcinoma recurred in the same portion of esophagus 3 years after chemoradiotherapy (Fig. 2). EMR was not indicated for the recurrent cancer because endoscopic ultrasonography estimated it submucosal invasion. Thus Modified PDT was performed in May, 2003. Forty-eight hours after injection of Photofrin® (2mg per kg), EDL was irradiated at a dose of 100 J/cm² via endoscopy attached transparent food on its tip. Seventy-two hours after Photofrin injection, irradiation of EDL at a dose of 60 J/cm² was added. One week after Modified PDT, endoscopy

---

**Table. 1:** Efficacy results of Modified PDT for GI cancers

<table>
<thead>
<tr>
<th>Tumor type</th>
<th>n</th>
<th>CR (%)</th>
<th>PR (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Esophageal cancer</td>
<td>6</td>
<td>4 (66.7)</td>
<td>2 (33.3)</td>
</tr>
<tr>
<td>Gastric cancer</td>
<td>10</td>
<td>9 (90.0)</td>
<td>1 (10.0)</td>
</tr>
<tr>
<td>Gastric cancer (advanced)</td>
<td>3</td>
<td>1 (33.3)</td>
<td>2 (66.7)</td>
</tr>
<tr>
<td>Rectal cancer*</td>
<td>1</td>
<td>1 (100)</td>
<td>–</td>
</tr>
</tbody>
</table>

* Not indicated for surgical operation or EMR.

(Follow-up period: 10 to 44 months.)
revealed a large laser ulcer coated with whitish necrotic tissue but no cancerous lesion remained by biopsy (Fig. 3). Three months after Modified PDT, laser ulcer healed completely and no cancerous lesion remained by biopsy (Fig. 4). There was no recurrence or metastasis until his death of cerebral hemorrhage 24 months after Modified PDT.

Case 2, 88 year-old woman, recurrent gastric cancer after EMR

In 2000, EMR was carried out for early gastric cancer; however it resulted in incomplete resection and the cancer recurred. She was followed up by endoscopy because she was not indicated for surgery by cerebral infarction and her advanced age. However, the recurrent cancerous lesion gradually enlarged and her anemia was progressive, therefore Modified PDT was carried out in January, 2003. Endoscopic examination before Modified PDT revealed superficial elevated cancerous lesion located in the anterior side of the middle portion of stomach (Fig. 5). The lesion was estimated submucosal invasion by endoscopic ultrasonography. Forty-eight hours after injection of Photofrin® (2mg per kg), EDL was irradiated at a dose of 80 J/cm² via endoscopy using cylindrical type of quartz fiber for contact laser irradiation. Seventy-two hours after Photofrin injection, irradiation of EDL at a dose of 80 J/cm² was added after removal of necrotic tissue (Fig.
One week after Modified PDT, endoscopy revealed a large laser ulcer coated with whitish necrotic tissue but no cancerous lesion remained by biopsy (Fig. 7). Three months after Modified PDT, laser ulcer healed completely and no cancerous lesion remained by biopsy (Fig. 8). There was no recurrence or metastasis 36 months after Modified PDT.

Discussion

PDT, a treatment now being used in patients with various types of cancers including GI tract, uses a combination of photosensitizer (a drug that is activated by light) and non-thermal low power laser light. Neither the photosensitizer nor the laser light alone can destroy the cancer cells; they must be used in combination.

The first endoscopic application of PDT for upper GI cancers was started in Japan (2). At that time, HpD as a photosensitizer and an argon-dye laser were used for patients with superficial and non-superficial esophageal cancer and with early gastric cancer. Hayata et al. concluded that PDT using HpD should be employed primarily in inoperable early-stage cancer, to reduce the extent of resection, or to make previously inoperable cases to operable because of the difficulty in early stage diagnosis and in determining all cases of lymph node involvement (2).

According to the recent remarkable development of endoscopic and other imaging technologies, gastroenterologists have regarded that superficial esophageal and early gastric cancers were not rare cases especially in Japan. The majority of esophageal cancer is squamous cell carcinoma and gastric cancer is very common in Japanese people. On the other hand, more than half of esophageal cancer is adenocarcinoma arising from Barrett’s esophagus and gastric cancer is extremely rare in Western white people. Under these circumstances, development of endoscopic PDT for GI cancers has been quite different in Japan and Western countries.

In 1995, Food and Drug Administration (FDA) of USA approved PDT using Photofrin® with diode laser (Diomed PDT laser system) for palliation of patients with completely or partially obstructing esophageal cancer (not only squamous cell carcinoma but also adenocarcinoma) after multicenter randomized trial (8). In 2003, FDA approved PDT using Photofrin® for the ablation of high-grade dysplasia associated with Barrett’s esophagus in patients who do not undergo esophagostomy, Canada and Europe also approved it in 2004. The other indication of PDT using Photofrin® approved by FDA is reduction of endo-bronchial obstruction in patients with nonsmall cell lung cancer who are not candidates for surgery or radiotherapy (5).

In Japan, Ministry of Health and Welfare approved PDT using Photofrin® for the patients with early-stage cancers of proximal lung (bronchial), esophageal, gastric, uterine cervix and with dysplasia of uterine cervix who are not indicated for surgery or other curative treatment including EMR. For the purpose of curative treatment for early stage cancers, EDL was developed. EDL enables irradiation of a pulsed laser with extremely high peak power in comparison with argon dye laser. Mimura et al. reported the cooperative clinical trial of PDT using Photofrin® with EDL on 27 patients.
with early gastric cancer. Complete responses (CR) were obtained in 88% of 24 assessable patients and the response rate was 100%. CR was observed in all cases of lesions of superficial depressed type without ulceration and/or with tumor diameter less than 2 cm. Regarding complications, mild cutaneous reaction and photosensitivity were seen and lasted several weeks\(^5\). The efficacy of PDT using Photofrin\(^\circ\) with EDL is satisfying; however, superficial depressed type gastric cancers without ulceration and/or with tumor diameter less than 2 cm are considered the indication for EMR. In 2004, PDT using a new photosensitizer named Laserphyrin\(^\circ\) (mono-L-aspartyl chlorin e6, Meiji Seika, Tokyo, Japan) with a new designed diode laser (II laser, Panasonic, Tokyo, Japan)\(^9\) was approved only for early lung cancer.

Under these conditions, we have designed a new therapy called "Modified PDT" to treat GI cancers not indicated for EMR or surgery. In spite of small number of patients, Modified PDT was remarkably effective for early stage of esophageal and gastric cancer in this study. This new method may be considered as curative therapy for early stage of GI cancers when the patients are not candidates for surgery or other curative therapy including EMR. Recently, Modified PDT was evaluated as salvage treatment for local failures after definitive chemoradiotherapy for esophageal cancer\(^10\). In combination with other treatment modalities, Modified PDT might be more valuable not only for early but also for advanced stages of GI cancers.

**Conclusion**

Modified PDT is remarkably effective and useful in the treatment of GI cancers which are not indicated for EMR or surgical operation. This technique may be considered an alternative therapy for not only esophageal but also gastric cancer, and even rectal cancer.

**Acknowledgement**

The authors wish to express their thanks to Dr. Michimaro Ejiri and Dr. Yoji Ishii (Nozatomon Clinic, Himeji, Japan) for their help and advice.

**References**


APPLICATION OF DIODE PUMPED ND:YAG LASER FOR ALLERGIC RHINITIS

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1: Ohshiro Clinic, Shinanomachi, Tokyo, Japan
2: Japan Medical Laser Laboratory, Shinanomachi, Tokyo, Japan

In Japan, nearly 15 to 20% of the population suffers from allergic rhinitis during the spring season. Conventional treatment with oral anti-histamines has side-effects such as drowsiness and dryness of the throat and is not acceptable for some patients. Laser treatment usually uses the carbon dioxide (CO2) laser to char the mucosal lining of the inferior turbinate in order to prevent onset of symptoms. This treatment has a downtime of roughly one month. Complications such as pain and hemorrhage sometimes require hospital admission. We have been using a flashlamp pumped Nd:YAG laser since 1993 with more favorable results both in efficacy and efficiency of treatment with less patient discomfort. A single treatment session takes around 2 to 3 minutes for both sides compared to 20 to 40 minutes with the CO2 laser and the downtime, which consists of rhinorrhea, is much shorter lasting only 2,3 days to up to one week. Treatment using the flashlamp pumped Nd:YAG laser is very reliable but improvement may be achieved using a diode laser pumped Nd:YAG laser where theoretically the homogeneity of the incident laser beam will increase. We report our experience using the hardware developed by Fibertech Co. on 40 patients as a preliminary report with further reports with larger series of patients ensuing. We also compare this new laser system with the conventional YAG laser and describe the advantage of the diode laser pumped Nd:YAG laser in the treatment of allergic rhinitis, especially in an office practice setting of ENT doctors.

Introduction

In Japan nearly 15-20% of the population suffer from cedar pollenosis during the spring season (mid-February to late-April). Symptoms consist of rhinorrhea and congestion of the nasal air passage accompanied by irritation and itch of the eyes. The severity of the symptoms ranges from slight discomfort to inability to conduct normal daily activities. The number of patients is growing year by year and the severity of symptoms is increasing in most patients. The most common treatment of pollinosis at local private ENT clinics is prescription of oral anti-histamines and topical nasal decongestants with steroids added in severe cases. However medication has its side-effects such as drowsiness and dryness of the throat and is not acceptable in many patients. Recent protocol for medication is commencing ingestion 2 to 3 weeks prior to the anticipated period of onset of symptoms. Oral ingestion must be continued throughout the whole season (2 to 3 months). Even so, the patients must protect themselves with masks and may suffer from symptoms on days with high pollen counts. The medical costs associated with allergic rhinitis may not be high for the individual but the prevalence of allergic rhinitis is such that the burden on the Japanese social medicine cannot be overlooked.

Laser ablation of the mucosal lining of the inferior turbinate using the carbon dioxide (CO2) laser was introduced in 1982 (1) and showed promising results ranging from 60 to high as 85% efficacy in prevention...
of onset of nasal symptoms. (2,3) However the CO2 laser ablation has certain drawbacks and at Ohshiro Clinic, we have been using the flash lamp pumped Nd:YAG laser for the treatment of allergic rhinitis since 1993. Recently we have started using a diode laser pumped Nd:YAG laser. This laser system was developed at our request by Fibertech Co. (Fig. 1). We show that Nd:YAG laser treatment is superior compared to CO2 laser treatment and that this newly developed laser system has advantages over the conventional flash lamp pumped laser system while the efficacy and safety is matched for the treatment of allergic rhinitis.

**Purpose of study**

The purpose of this study was to reconfirm the safety of the diode laser pumped Nd:YAG laser system compared to the conventional flash lamp pumped Nd:YAG laser system. We also sought any idiosyncrasies of this new laser system that might need refinement for use of this laser system. Our goal is to create a laser system which is safe, effective, durable and easily handled by those who are not use to lasers.

**Materials and Methods**

40 consecutive patients were enrolled in the study for the treatment using the diode laser pumped Nd:YAG laser during April 16, 2005 to May 2, 2005. All patients were treated by well experienced MD’s (Table. 1). Following initial examination patients were seated in an armchair and were anesthetized with 8% lidocaine solution sprayed into each nostril (Fig. 2). Treatment commenced immediately following anesthesia (Fig. 3). Treatment parameter was such: 8 w, 0.5second laser irradiation followed by 0.5 second rest, total irradiated energy at 200 joules. Patients returned to the clinic at 2 to 4 weeks after treatment for assessment. Subjective assessment of the effects (Table. 2) was determined as ER (efficacy rate) = (extremely effec. + effec.) / total patients.

<table>
<thead>
<tr>
<th>Wave length</th>
<th>1064nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output power</td>
<td>0.1-8w</td>
</tr>
<tr>
<td>Mode</td>
<td>CW</td>
</tr>
<tr>
<td>Silica fiber core diameter</td>
<td>600µm</td>
</tr>
<tr>
<td>SMA connector Laser tip</td>
<td>round glass tip Φ2mm</td>
</tr>
<tr>
<td>Width</td>
<td>180mm</td>
</tr>
<tr>
<td>Hight</td>
<td>460mm</td>
</tr>
<tr>
<td>Length</td>
<td>460mm</td>
</tr>
<tr>
<td>Total weight</td>
<td>24kg</td>
</tr>
</tbody>
</table>

**Table. 1**: Specification of Diode laser pumped Nd:YAG laser produced Fiber Tech Co. Japan (Fig. 1)

**Table. 2**: Subjective Assessment of the effects

<table>
<thead>
<tr>
<th>Effect</th>
<th>Extremly effective</th>
<th>&gt;90% clearance of symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective</td>
<td>60-90% clearance of symptoms</td>
<td></td>
</tr>
<tr>
<td>Moderately effective</td>
<td>30-59% clearance of symptoms</td>
<td></td>
</tr>
<tr>
<td>Not effective</td>
<td>0-29% clearance of symptoms</td>
<td></td>
</tr>
<tr>
<td>Exacerbation</td>
<td>worsening of symptoms</td>
<td></td>
</tr>
</tbody>
</table>

Efficacy was determined as ER (efficacy rate) = (extremely effec. + effec.) / total patients.
Results

Of the 40 patients treated with the diode laser pumped Nd:YAG laser, 26 patients were available for follow up. The efficacy ratio is determined as the sum of extremely effective and effective patients divided by the total number of patients treated. Two patients (7.7%) and 9 patients (34.6%) responded extremely effective and effective respectively for a efficacy rate (ER) of 42.3% whereas 7 patients (26.9%) responded moderately effective and 6 patients (23.1%) responded as not effective. There were no cases in which symptoms were exacerbated and no side-effects requiring medical attention was observed. Two patients (7.7%) stated that they could not determine whether or not laser had any effect even though they felt that the symptoms were alleviated (Table. 3). Usual reaction to laser treatment consists of rhinorrhea. We inform all patients that though the severity may differ from patient to patient, rhinorrhea will appear as early as 1 hour following treatment and last as long as 1 week with the most severe rhinorrhea lasting for the first 2 to 3 days. In this present study 19 patients had documentation on the subject. Four patients had no rhinorrhea at all, post-treatment (of which 3 had no effect of treatment). Four, two, one and one patients had increased rhinorrhea for 1, 2, 3 and 5 days respectively. Seven patients had increased rhinorrhea for 1 week (Table. 4). No side effect requiring medical attention was noted. Rhinorrhea lasted on the average of 3.4 days. The presence or lack of rhinorrhea has no implication on treatment outcome. This result does not differ from our previous experience.

Discussion

It is obvious from our result that the safety of the diode laser pumped Nd:YAG laser is compatible with the conventional flash lamp pumped Nd:YAG laser system. Theoretically, there should be no difference between the two, since both laser systems emit the same 1064nm near infra-red laser beam used at nearly the same parameter (8 w 0.5 sec pulse length, total energy 200 joules for the diode laser pumped laser, and 10 w 0.5 sec pulse length, total energy 200 to 250 joules for the flash lamp pumped laser). However, there may be subtle discrepancies between utility of the laser systems which may compromise the safety of the treatment. From our experience, it seemed that the patients experienced less pain during treatment when using the diode laser pumped system compared to the flash lamp pumped system. This can be attributed to the fact that treatment using the diode laser pumped system was performed at 8w which is 20% lower than the conventional treatment method. Previous treatment

<table>
<thead>
<tr>
<th>Table. 3: Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment period: April 16, 2005 to May 2, 2005</td>
</tr>
<tr>
<td>Extremely effective</td>
</tr>
<tr>
<td>Effective</td>
</tr>
<tr>
<td>Moderately effective</td>
</tr>
<tr>
<td>Not effective</td>
</tr>
<tr>
<td>Exacerbation</td>
</tr>
<tr>
<td>Not determined</td>
</tr>
<tr>
<td>ER=11/26 42.3%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table. 4: Side-effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>No complication arose that required medical attention</td>
</tr>
<tr>
<td>Post-treatment rhinorrhea:</td>
</tr>
<tr>
<td>19 patients had documentation on the subject</td>
</tr>
<tr>
<td>4 patients had no rhinorrhea at all, post-treatment (of which 3 had no effect of treatment).</td>
</tr>
<tr>
<td>4, 2, 1, 1 patients had increased rhinorrhea for 1, 2, 3 and 5 days respectively</td>
</tr>
<tr>
<td>7 patients had increased rhinorrhea for 1 week</td>
</tr>
<tr>
<td>Average period of rhinorrhea = 3.4 days</td>
</tr>
</tbody>
</table>
parameters were set by past experience alone and no study has been performed on identifying the optimum parameter. This may have affected the ER of the study. In a previous unpublished study on the efficacy of Nd:YAG laser treatment using 10w, the ER of experienced MD’s was 67.5%. The 42.3% ER in this study is substantially lower and if the 8w setting alone is responsible for the decrease in ER we must reconsider the parameter of the new laser system. However the design of this study was set to confirm the safety of the laser system and hence the time period of the study (late April to early May) may not have been optimal to identify the best treatment setting. The period of late April to early May is usually the end of the cedar pollenosis season and patients presenting symptoms during this period may suffer symptoms less than what they suffered earlier in the season and may have found difficulties in responding to the actual percentage of resolution attributable to laser treatment. There were 2 patients who could not determine whether it was the laser treatment or spontaneous resolution of symptoms at the end of the cedar pollenosis season. In this study we did not discriminate between seasonal pollenosis and perennial allergic rhinitis and this may have affected the ER of a single treatment since patients with perennial allergic rhinitis usually require repeated treatment for the alleviation of symptoms. This study confirms the safety of this laser system but further study of the ER of the diode laser pumped Nd:YAG laser is required.

The laser treatment of allergic rhinitis first appears in literature using the carbon-dioxide (CO2) laser in 1982 (1). Since then, usage of numerous lasers using various methods have appeared, (4,5,6,7). The use of the Nd:YAG laser first appears in Medline in 1995 (however there are reports earlier than this not listed in Medline). At Ohshiro Clinic we have adopted this contact method of Nd:YAG laser irradiation to the inferior turbinate mucosa with success (9,10,11). Probably the greatest difference between treatments of allergic rhinitis using the CO2 laser and the Nd:YAG laser is the goal and aim of the treatment. The goal of the CO2 laser treatment is to either ablate or char the nasal mucosal lining of the inferior turbinate which result in complete destruction of mucosal structure. Following a month long healing process the mucosa is replaced by scar tissue and hence mucosa is unable to react to allergic stimuli. This treatment can be performed in an outpatient basis but must be performed in a surgical setting. Topical surface anesthesia must be performed several times and in some cases the time for anesthesia alone can take up to 20 minutes. Treatment is performed under the guide of an endoscope and takes 15 to 20 minutes per turbinate. Although nasal packing is not necessary, there is the risk of post-operative hemorrhage sometimes requiring hospitalization. The patient must withstand roughly 2 weeks of complete nasal obstruction and rhinorrhea, and another 2 weeks of crust removal and occasional nasal bleeding and tenderness. The patient can be aware of the effect of the treatment only after the one month healing process and if the patient has only seasonal allergic rhinitis, he/she must wait until the pollen season to actually know if the treatment was effective or not. Problems associated with CO2 laser treatment for pollenosis are shown in the Table. 5. This type of treatment needs to be performed in large hospitals with ENT departments and may be acceptable for the severe rhinitis patients but is hardly possible in a small private practice setting with patients presenting with less severe symptoms.

As for the treatment using Nd:YAG laser, total destruction of the mucosal lining of the inferior turbinate is not the treatment objective. The mucosa remains intact even after treatment and there is no visible change to the mucosa (Figs. 4 & 5). Treatment goal is to transfer enough energy to the nasal mucosa to perhaps denature and change the physical properties of the mucosal cell membrane as to diminish any reactivity to the inhaled allergens. Treatment starts with the application of 8% lidocaine anesthesia. The anesthesia is sprayed 2 to 4 times per nostril. The patient will feel a stinging sensation for roughly 30 seconds where upon the anesthesia is completed. Laser irradiation can immediately be performed by slowly progressing the laser probe into the nasal orifice. No pressure is applied while the laser is being emitted, and no endoscope is required for the procedure. Two hundred joules of laser is irradiated to the surface of inferior turbinate which takes only about 50 seconds per turbinate and the whole procedure including anesthe-

<table>
<thead>
<tr>
<th>Table. 5: Problems Associated with CO2 Laser Treatment for Pollinosis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Treatment period</strong> •must be performed well before onset of symptoms</td>
</tr>
<tr>
<td><strong>Treatment time</strong> •20 to 30minutes time for each naris</td>
</tr>
<tr>
<td><strong>Pain</strong> •high despite local anesthetics</td>
</tr>
<tr>
<td><strong>Sequela</strong> •post-operative hemorrhage, sometimes requiring hospitalization</td>
</tr>
<tr>
<td>•pain</td>
</tr>
<tr>
<td>•rhinorhea and complete nasal obstruction lasting for 2 weeks.</td>
</tr>
<tr>
<td><strong>Downtime lasts for 1 month</strong></td>
</tr>
</tbody>
</table>

SHUNJI FUJII ET AL.
sia requires only 2 to 3 minutes (Table. 6). The patient may feel occasional pain but this is well tolerable as can be seen in our experience of children as young as 6 years of age. The treatment using the Nd:YAG laser is a quick procedure that does not require a surgical setting with no risk compared to that of the CO2 laser. The greatest advantage of the Nd:YAG laser treatment is that there is very little post-operative discomfort. While those treated with the CO2 laser must suffer symptoms for approximately 1 month, those treated with the Nd:YAG laser can resume normal daily activities immediately and will only suffer from rhinorrhea which itself will last for 1 week with the first 2 to 3 days the most severe. Even then the amount of nasal discharge is much less compared to onset of allergic rhinitis and in many cases the amount of discharge is negligible. Another advantage of the Nd:YAG laser treatment is that it can be performed at any time, even after the onset of symptoms, whereas the CO2 laser treatment must be performed well before the onset of symptoms, sometimes as early as October or November of the previous year in order to prepare for

**Fig. 4-1:** Pre-treatment intranasal photograph. Edema of the mucosa surface can be seen along with discharge.

**Fig. 4-2:** Post treatment intranasal photograph.

**Fig. 5-1:** Pre-treatment intranasal photograph.

**Fig. 5-2:** Post-treatment intranasal photograph. Edema of the mucosa is reduced and there is no nasal discharge present. Note there is no visible change to the mucosal surface such as scarring or charring.
the spring season. The ease and safety of the Nd:YAG laser treatment allows both the surgeon and the patient certain benefits. The surgeon can treat more patients per day without worrying of any post-operative problems and for patients, they can receive repeat treatments if the first treatment does not suffice. Roughly 70% of patients respond favorably after a single treatment. Nearly half of those who did not respond to the first treatment will respond after successive second and third treatments for a cumulative response rate of 84% (Table. 7). The disappointment that the patient will feel after a failed attempt with the CO2 laser is obviously much greater and almost all patients will feel reluctant to receive another CO2 laser treatment.

Our ER of 67.5% is a modest data because of the strict criteria of efficacy. This data was accumulated in 2002 which was the worst cedar pollinosis season in Japanese history. From experience the amount of pollen in the air directly affects the severity and prevalence of pollinosis and the outcome of treatment. This is why it is difficult to directly compare any parameter of laser treatment unless the comparison takes place simultaneously. We have evidence that the ER in other years match those reported in literature.

Though we have demonstrated the superiority of the Nd:YAG laser treatment over CO2 laser treatment, the number of institution or private clinics using the Nd:YAG laser is small and there is no sign of increase. Small clinics may continue to use the CO2 laser while larger institutions may experiment using other devices. The reasons why the Nd:YAG laser is not as popular as the CO2 laser can be considered as follows. First concerning the hardware, the CO2 laser was one of the earliest developed lasers. Its utility as in being used as a laser scalpel or for ablation and dessication and the clearly visible tissue-laser interaction makes the laser useful in just about all fields of medicine. The relatively small size of the laser system and low maintenance costs is another reason for its popularity. Fig. 6 shows the picture of Nd: YAG Laser (Heracules 5040 LASERSCOPE Co., Ltd). Specification of machine is shown in the Table. 8, its deeper penetration depth of the incident laser beam allows for very effective interstitial laser treatments but the lack of visible laser tissue interaction can cause unwanted damage to surrounding tissue and hence treatment using the Nd:YAG laser requires more experience on the part of the attending surgeon. A flash lamp pumped system is much larger than the gas lasers and requirement for an effective cooling system makes the system even larger. The short lifespan of the flash lamp and running costs associated with this makes the Nd:YAG laser a much more expensive system to operate and using such machinery only on limited basis of seasonal pollinosis may not be appealing to private practitioners.

Another reason that laser treatment of allergic rhinitis is not widespread lies in the fact that there is very limited access to lasers both for the ENT doctors and patients. Only limited number of doctors has access to laser treatment and can gain only limited

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**Table. 6: Application of Nd:YAG Laser (Benefits Over CO2 Laser)**

<table>
<thead>
<tr>
<th></th>
<th>Treatment period</th>
<th>Treatment time</th>
<th>Pain</th>
<th>Sequela</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><em>may be performed immediately before or even after onset of symptoms</em></td>
<td><em>2 to 3 minutes for both narii</em></td>
<td><em>low with usage of local anesthetics</em></td>
<td><em>rhinorrhea lasts 2,3days. Iweek at most nasal obstruction in low number of cases</em></td>
</tr>
<tr>
<td>Shortness of down-time</td>
<td>allows patients to receive multiple treatments</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Table. 7: Comparison of Nd:YAG laser and CO2 laser treatment for pollinosis**

<table>
<thead>
<tr>
<th>Clinic</th>
<th>Laser used</th>
<th>Treatment time</th>
<th>Nasal function</th>
<th>Side effects</th>
<th>Appearance of effect</th>
<th>Treatment period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ohshiro clinic</td>
<td>Nd:YAG</td>
<td>5 minutes</td>
<td>Retains normal function</td>
<td>2,3 days up to 1 week (rhinorrhea, obstruction)</td>
<td>As early as 2,3 days normally 1 week</td>
<td>Treatment during the pollen season is possible</td>
</tr>
<tr>
<td>Other clinics and institutions</td>
<td>CO2, Nd:YAG, KTP</td>
<td>20-40 minutes</td>
<td>Dysfunction due to ablation</td>
<td>1 months (pain, obstruction, rhinorrhea)</td>
<td>After 1 months</td>
<td>Must be treated before season</td>
</tr>
</tbody>
</table>

---

**Table. 8: Specification of Heracules 5040 LASERSCOPE Co., Ltd.**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flashlamp pumped Nd:YAG laser</td>
<td>Wave length 1064nm</td>
</tr>
<tr>
<td></td>
<td>Max. Output 40w</td>
</tr>
<tr>
<td></td>
<td>Silica fiber core diameter 600µm</td>
</tr>
<tr>
<td></td>
<td>Sapphire tipped hand piece is used</td>
</tr>
</tbody>
</table>
experience. Since the number of doctors performing the procedure is limited to large institutions which have access to lasers, mainly the CO2 laser, the number of patients receiving treatment is small. Most doctors opening new private practices will probably not incorporate laser treatment at all and those few who do will rather endorse the CO2 laser from their sparse experience for reasons mentioned above rather than gamble with a new device, even though the Nd:YAG laser has more therapeutic benefits for patients.

At Ohshiro clinic, we were well aware of the disadvantages of the flash lamp pumped Nd:YAG laser hardware. The media attention that we have received for the Nd:YAG laser treatment of allergic rhinitis has led to a gross increase in patient volume. This motivated us to develop a new Nd:YAG laser system that would clear all of the above mentioned problems. At our request, Fibertech Co. developed a diode laser pumped Nd:YAG laser used in this study. The greatest difference of the newly developed hardware compared to the conventional laser hardware is its size. The size of the laser system is just slightly larger than a desk top computer (Fig. 7). Just the compact size of the laser system solves most of the problems associated with incorporating a Nd:YAG laser in the treatment armament of a private office practice. By using a diode laser pumping system, the total size of the system can be decreased and also the diode laser pumping system does not require a large cooling system which can decrease the size even more. The energy efficiency of the laser diode allows the laser to operate with the normal 100 V electrical supply found in normal house-
patient discomfort compared to the CO₂ laser. The newly developed diode laser pumped Nd:YAG laser can be used safely and effectively with less patient discomfort. Although further studies on the optimum parameter for the treatment of allergic rhinitis need to be conducted, we hope that this new diode laser pumped Nd:YAG laser will encourage more ENT doctors to treat allergic rhinitis using lasers.

References

1: Mittelman H.

2: Janda P, Sroka R, Baumgartner R, Gravens G, Leuniq A

3: Kawamura S, Fukutake T, Kubo N, Yamashita T, Kumazawa T.

4: Serrano E, Percodani J, Yardeni E, Lombard L, Laffitte F, Pessey JJ.

5: Levine HL.

6: Kunachak S, Kulapaditharom B, Prakunhungsit S.

7: Leunig A, Janda P, Sroka R, Baumgartner R, Grevers G.
Ho:YAG laser treatment of hyperplastic inferior nasal turbinates.

8: Ito H, Suzuki M, Mamiya S, Kitao S, Takagi I, Baba S.


10: Itoh H, Nishimura J, Nakamura Y, Sugiyama K, Baba S.
Study on the long-term observation of Nd: YAG laser surgery for allergic rhinitis


12: Wang HK, Tsai YH, Wu YY, Wang PC.

13: Imamura S, Honda H.
Introduction

As early as 1917, Einstein expounded the theory related to "Light Amplification by Stimulated Emission of Radiation". It was not until 1960, however, that Maiman produced the first operational laser. Lasers of various wavelengths, both gas and solid state became available subsequently but it was the CO2 Laser produced by Kumar Patel of Bell Labs in 1964, that showed promise of being applicable to surgery due to the fact that its beam was shown to be highly absorbed by water. Since human tissue comprises between 75% to 90% water, it follows that the CO2 laser beam can play many important roles in the surgical field, from cutting, through ablation to tissue welding and photobiomodulation. Its basic action in tissue is photothermal, almost instantaneously vaporizing target tissue (at appropriate power densities) by raising temperatures to well over 100°C. Because of the selective absorption in water, however, minimal damage is caused to adjacent tissue. The CO2 laser offers the following benefits: reduction in trauma; almost bloodless surgery compared with the conventional scalpel; improved therapeutic results; reduced risk of infection; less scarring; precisely controlled surgery which limits injury to normal skin; and safe and effective recovery for many surgical conditions, often faster than conventional approaches and therefore achieving shorter hospital stays. From his experience with the CO2 laser encompassing some four decades, the author presents herein his accumulated knowledge of all types of CO2 laser surgery, even in patients with any of the coagulopathies. The CO2 laser is thus well-and widely-adapted for current, and future, clinical indications, offering a versatile and practical alternative to traditional scalpel surgery in many medical fields.

Key words: CO2 laser, photothermal vaporization, photocoagulation, tissue welding, Surgical scalpel

The carbon dioxide laser (CO2 laser) was one of the first 4 major lasers to be developed, and is now successfully employed for surgical procedures not only in the fields of plastic and general surgery field, but also in many other specialities, including dermatology, gynecology and otorhinolaryngology. In dermatosurgery, CO2 laser resurfacing for rejuvenating photoaged skin remains the gold standard. The CO2 laser produces a beam of mid-infrared energy at a primary band of 10,600 nanometers (nm) or 10.6 µm, at which wavelength the laser beam is very highly absorbed by water. Since human tissue comprises between 75% to 90% water, it follows that the CO2 laser beam can play many important roles in the surgical field, from cutting, through ablation to tissue welding and photobiomodulation. Its basic action in tissue is photothermal, almost instantaneously vaporizing target tissue (at appropriate power densities) by raising temperatures to well over 100°C. Because of the selective absorption in water, however, minimal damage is caused to adjacent tissue. The CO2 laser offers the following benefits: reduction in trauma; almost bloodless surgery compared with the conventional scalpel; improved therapeutic results; reduced risk of infection; less scarring; precisely controlled surgery which limits injury to normal skin; and safe and effective recovery for many surgical conditions, often faster than conventional approaches and therefore achieving shorter hospital stays. From his experience with the CO2 laser encompassing some four decades, the author presents herein his accumulated knowledge of all types of CO2 laser surgery, even in patients with any of the coagulopathies. The CO2 laser is thus well-and widely-adapted for current, and future, clinical indications, offering a versatile and practical alternative to traditional scalpel surgery in many medical fields.

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touch atraumatic ablation, provided suitable instrumentation is available.

Early in 1972 (1) we embarked on a two-fold project designed to investigate the application of the CO2 laser in surgery as a whole, while at the same time attempting to develop an apparatus which would be human engineered and designed specifically for clinical surgery bearing in mind the physical conditions and requirements of the average operating room and the idiosyncrasies of the average surgeon.

Close cooperation between the surgeons and the industry gave rise to the introduction of various further modifications and the development of accessories designed to broaden the application of the CO2 laser, in order to encourage other surgical specialties to introduce this modality into their armamentarium. At the same time, publication of articles in professional journals, participation in congresses and symposia were all contributory to spreading the gospel, in spite of the natural skepticism of the author’s colleagues (see bibliography).

In 1975, the first international symposium of laser surgery was held in Tel-Aviv and this gave rise to the foundation of the International Society for Laser Surgery which has since held meetings every alternate year and whose membership has grown rapidly and steadily. This also inspired the formation of numerous regional and national societies throughout the world, with the result that many other lasers, each with its specific application, have been introduced into the medical field.

Sufficient experience has been accumulated for experienced clinicians to determine where the CO2 laser has a definite application in surgery and what advantages it has over other modalities. This can best be classified under the following headings.

**OPERATIONS WHERE THE ANTICIPATED BLOOD LOSS WOULD BE SIGNIFICANT**

This could well encompass practically every surgical specialty, but is particularly well demonstrated by orthopaedic and plastic surgery, where large excisions are involved.

Mastectomies (Figs. 1-2), mammoplasties, lipectomies, and other procedures of a similar nature have been performed by ourselves and others (2,20,48,56,66) whereas in hand surgery it is worthy of mention that not only is the saving of blood impressive in these cases, but the fact that the use of a tourniquet can be avoided reduces the postoperative morbidity and permits a more rapid return of function. In neonatal and pediatric surgery the use of the CO2 laser is, in the opinion of most of us, mandatory (53,54) because of the vital importance of saving blood in these cases (38,53,54).

**SURGERY PERFORMED IN HIGHLY VASCULAR AREAS OF THE BODY**

Perhaps the best examples of this are tongue surgery (Figs. 3-4) and surgery of the scalp (Figs. 5-6) and solid organs which are being performed routinely by ourselves and others by means of the CO2 laser with impressive results (7,14,31,56,66). The fact that the postoperative course in patients who have undergone partial or total glossectomies is almost entirely painless while postoperative oedema is negligible, has in most cases made tracheostomies unnecessary and shortened the hospitalization considerably. It has also been shown that post-operative deformity of the tongue can be minimized by allowing healing by secondary intention to take place. This is facilitated by the lack of post-operative pain.

**EXTIRPATION OF HIGHLY VASCULAR TUMOURS**

Many cases of cavernous hemangioma (Figs. 7-10) Kaposi Sarcoma, and hemangiosarcoma have been extirpated by us and others (15,56). This enables us to avoid hypotensive anaesthesia and ligation of feeding arteries (15,66).

**SURGERY FOR MALIGNANT DISEASE**

It is universally accepted by surgeons that the surgery of cancer should be performed with minimal opening of blood vessels and lymphatics and manipulation of tissue together with maximal visualization. Since the CO2 laser seals the blood vessels and lymphatics during surgery, while at the same time permitting an almost non-touch extirpation to be performed, whereas the haemostatic effect enables the surgeon to distinguish accurately between pathologic and normal tissue, its application in cancer surgery is obvious. Those of us who have this modality at our disposal are using it routinely for the excision of accessible malignant disease in spite of the fact that our clinical follow-up is still too short to be able to reach definite conclusions regarding its long term prognosis. Considerable experimental evidence exists, however (5,16,56), to indicate that the hypothesis upon which its introduction into cancer surgery is based, is well-founded. We have performed well over 300 wide excisions with primary skin grafting of malignant melanomata and have had no
reason to regret having introduced this modality as a routine in our department (37,56,66). (Figs. 19-20) The reduction of post-operative pain and edema in mastectomy cases has been shown to be an added advantage in surgery for cancer of the breast. (Figs. 1-2)

OPERATIONS PERFORMED THROUGH HIGHLY INFECTED TISSUE

The excision of burns, synergistic gangrene, and decubitus ulcers are examples par excellence of the application of the CO2 laser in this connection. The intraoperative sealing of blood vessels and lymphatics tends to eliminate the spreading of infection while at the same time the laser sterilizes the area of the debridement. (Figs. 15-16) Infected pilo-nidal sinuses are excised with the laser and the residual wound closed primarily, thus avoiding the usual protracted recovery period (39,66).

SURGERY PERFORMED ON PATIENTS SUFFERING FROM COAGULOPATHIES

The CO2 laser has virtually revolutionized the surgical approach to these patients. In haemophiliacs, for example, it is possible to significantly reduce the amount of antihemophilic factor administered pre-, intra- and post-operatively. This not only reduces the post-operative morbidity but makes the use of the laser very cost-effective. (Figs. 17-18) It is perhaps worthy of note that the first two cases of AIDS reported in Israel involved haemophiliac children and there are now 120 haemophiliacs with AIDS.

MICROSURGERY

The addition of a micromanipulator has enabled the laser to be applied to various microscopic procedures, notably, in gynecology, otorhinolaryngology and neurosurgery.

THE AMBULATORY TREATMENT OF CUTANEOUS LESIONS

In dermatologic surgery, the laser beam is used for the excision or vaporization of lesions. The procedure, which is generally conducted in an outpatient clinic, is rapid and uncomplicated, bloodless, sterile, almost painless, and well tolerated by children and the elderly. Postoperatively, there is no discomfort for the patient and no dressings are required; postoperative pain and infective complications do not occur. The treated areas heal rapidly because the skin appendages escape permanent damage. The cosmetic results of the treated areas are superior to those obtained by other methods and there is only minimal scarring (28,66).

LASER DERMABRASION

Xeroderma pigmentosum, Farmer’s skin, Bowen’s disease, post acne and burn scars, extensive pigmentation (giant nevi, Becker’s nevi, nevus unius lateris, and decorative tattoos), large seborrheic keratoses, leukoplakia, pruritus vulvae and ani, crural and decubitus ulcers, and burn eschars, are all treated satisfactorily by dermabrasion with the CO2 laser. It has recently become very popular in cosmetic surgery.

Treatment method: The defocused beam is scanned over the area to be treated in two directions at an output of approximately 5 Watts. The debris is then wiped away with a wet pad and the depth of abrasion estimated. This can be repeated until the required depth is reached. This procedure enables us to perform dermabrasion, with an accurate control of depth and extent, without bleeding, and without the scattering of debris and blood, more precisely and evenly than the conventional methods. The healing process is rapid with minimal pain and good cosmetic results. Recently, various scanners have been introduced for performing resurfacing in the treatment of facial wrinkles and acne scars. This is intended to make the procedure more controllable.

MICROANASTOMOSIS AND TISSUE WELDING

Since the CO2 laser had been shown to seal blood vessels, lymphatics, bile cannaliculi, renal tubules, alveoli, etc. (this being a welding process and not coagulation) it is logical to assume that, provided the correct output and technique are adopted, the CO2 laser should be able to be used for welding tissue. Microvascular anastomosis, as well as that of vasa deferentia, fallopian tubes, ureters, bowel and even welding of skin have been shown to be practical. This, therefore has opened a new and exciting field of application of this versatile modality.

INCISION OF SPECIFIC TISSUES

The best example of the above is the incision of the spinal meninges. This can be performed under microscopic control without manipulation of the tissue with the resultant effect on the nerve roots.
SIMULTANEOUS MONITORING

Operations can be performed on the brain or heart under E.E.G. or E.K.G. control since this is merely a beam of light and does not interfere with the monitor. It is worthy of mention that patients who have pacemakers implanted should be operated on with the laser since electrocautery systems can produce cardiac arrest. The CO2 laser can and should also be used for replacing pacemakers.

CAVITATIONAL SURGERY

With the introduction of various laser endoscopes the CO2 laser has become the modality of choice in many cavitational procedures, notably intra-abdominal, intra-thoracic, intra-articular and rectal and vaginal (49,51,67-70). One of the problems related to the use of the CO2 laser in cavitational Surgery is the fact that until recently an optical fiber capable of transmitting the beam through flexible endoscopes did not exist. This led to the introduction of various photocoagulators such as the Nd:Yag laser into endoscopic surgery merely because of the ability to transmit their beams through optical fibers. In spite of many years of research, it was not until 1990 that Prof. Croitora et al. perfected a hollow plastic waveguide which showed promise of solving this problem. This consists of a plastic tube which is flexible and inert. To enable the plastic tube to transmit the laser energy without being damaged, two layers are deposited on the internal wall. A metal layer and on top of it a dielectric layer. Thus the transmission medium in such a hollow waveguide is the air and the light incident on the walls is reflected by the two layers, eventually exiting at the end (82). After testing the prototypes of these waveguides experimentally in animals their clinical application commenced. Metal waveguides have also been introduced into clinical practice and have proved their worth.

GYNAECOLOGY

Surgical procedures on the uterine cervix have been performed to date with CO2 Laser by means of a colposcope and micromanipulator (3). It was felt that with the availability of a waveguide these procedures could be performed under direct vision resulting in significant simplification. This was shown to be the case where benign tumors of the vagina and uterine cervix were concerned. Cervical erosions and C.I.N. could also be dealt with satisfactorily. Laparoscopic procedures such as adhesiolysis and the treatment of endometriosis and follicular cysts can be performed with relative ease and safety. It is worthy of note that the CO2 Laser is accepted as the modality of choice for treating condylomata accuminata and herpes of the genitalia.

ORAL SURGERY and OTORHINOLARYNGOLOGY

It was found that using waveguides in association with an instrument designed by Stone and the author rendered periodontic procedures relatively simple, accurate and safe. In oral surgery the waveguides made lesions more accessible and thus simplified many procedures by eliminating the necessity for introducing mirrors in order to divert the laser beam. In E.N.T. Surgery such procedures as tonsillectomy (by waveguide probe) resulted in simplification of the procedure with elimination of bleeding and almost complete elimination of post operative pain. This also applies to turbinectomy (101). Adenoidectomy by vaporization through a nasopharyngoscope should also be practical, whereas lesions of the pharynx and vocal cords could be dealt with adequately by application of the waveguides under direct vision.

PROCTOLOGY

Access to various lesions of the rectum was easily gained through a standard rectoscope and accurate vaporization performed. Pedunculated lesions could be removed by transection of the pedicle and vaporization of the base. Anal fistulae could be treated by inserting the waveguide Into the fistula under digital control and withdrawing it slowly while operating the laser, thus vaporizing the tract. This greatly simplified the treatment of this condition.

THORACIC SURGERY

Various surgical procedures on the lungs have been performed using the Optoprobe through a thoracoscope.

INTRA-ABDOMINAL PROCEDURES

In order to assess the applicability of the waveguide in various laparoscopic procedures such as, for example laparoscopic cholecystectomy, they were tested first by performing cholecystectomies through laparotomies. This demonstrated the feasibility of applying the waveguides in these procedures.

I hope, in the near future to be able to report on work being undertaken at present in orthopaedic
surgery and urology. It has long been felt that surgical procedures within the urinary bladder could be performed more accurately and more safely with the CO2 laser than with those currently in use such as the Nd:Yag. The latter was introduced into urology for two main reasons:

1. The beam could be transmitted through a flexible optical fiber.
2. Since the bladder is usually distended with saline, the CO2 beam would be absorbed in the saline and therefore rendered ineffectual.

The disadvantage of the Nd:Yag laser lies in the fact that the beam penetrates much more deeply than the CO2 beam and this together with back scatter causes significantly more tissue damage which may result in perforation of hollow organs. Accordingly, it was decided to inflate the bladder with CO2 in experimental animals in order to test the effect of the CO2 laser beam on the bladder mucosa and compare it with that of other lasers.

**IN CONCLUSION**

It is my considered opinion, that one of the main advantages of the use of lasers in our profession lies in the fact that they enable us to perform various procedures without contact with the tissue treated whereas its combination with simultaneous haemostasis and minimal residual tissue damage, sterilization of the surgical wound and reduction in post-operative pain are additional decided advantages. Any surgeon who feels that he is incapable of operating without tactile feedback does not need a laser and it was Leon Goldman who in the early days coined the saying: "If you do not need the laser don’t use it". Training programs designed to teach people to operate with lasers must concentrate on acquainting them with non-contact surgery or fail in their objective. Six hundred odd surgeons from all parts of the world have received instruction by me on the use of the CO2 laser in various fields of surgery and it is this aspect that has been stressed throughout.

When I first started to investigate the application of the CO2 laser in surgery I promised myself that if I come to the conclusion that this modality did not have any advantages over others I would say so for the sake of intellectual honesty. Fortunately, this has not been necessary since, in my considered opinion the CO2 laser has undoubtedly proved its value as a surgical tool and will remain the laser of choice for surgery.

It will in my opinion continue to gain in popularity both as a ‘light knife’ and for accurate debulking of tissue by vaporization. It is doubtful indeed whether the introduction of various contact tips for other lasers will result in an expansion of their acceptance since this tends to bring them into direct competition with the electrocautery approach.

A review of the literature relating to CO2 laser surgery has shown that there are two contraindications to its wider use by the medical profession and they are the bulkiness and expense of the existing equipment. This is probably one of the reasons why it is not used more for biostimulation and LLLT because it has been clearly shown that applying it at low incident power densities either by reducing the power or defocusing the beam can make it applicable for this purpose. I truly believe, and the literature bears me out, that the CO2 laser is thus well- and widely-adapted for current, and future, clinical indications, offering a versatile and practical alternative to traditional scalpel surgery in many medical fields.
Figs. 1-2: In operations where anticipated etc. Cancer of breast.

Figs. 3-4: Surgery performed in highly vascular areas. Surgery of the tongue.

Figs. 5-6: Surgery in the scalp.
Figs. 7-8: Extirpation of highly vascular tumors. Cavernous hemangioma in an adult.

Figs. 9-10: Extirpation of highly vascular tumors. Cavernous hemangioma in a child.

Figs. 11-12: Ambulatory treatment of cutaneous lesions. Seborrheic Keratoses.
Figs. 13-14: Laser Dermabrasion. Xeroderma pigmentosum.

Figs. 15-16: Operations in highly infected tissue. Synergistic gangrene.
Figs. 17-18: Surgery on patients with coagulopathies. Circumcision in a hemophiliac.

Figs. 19-20: Pediatric and Neonatal Surgery. The use of the laser here is, in my opinion, mandatory. Lymphangioma in the newborn.
REFERENCES

Academic Press, Jerusalem.


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PROF ISAAC KAPLAN Profile

Prof of Surgery, and past incumbent of the Chair of Plastic surgery, Tel Aviv University.

1919 - Born and educated in South Africa.

Served British Army in North Africa during World War II.

1950 - Qualified in Medicine at the University of Witwatersrand (Johannesburg, South Africa).

1952 - Emigrated to Israel.

1954 - Completed Specialist training in General Surgery at the Hadassah University Hospital, Jerusalem.


1958 - Established and headed the Dept. of Plastic and reconstructive and Maxillofacial Surgery, Beilinson Hospital, Israel. (Tel Aviv University).

1967 - Established the first Burns Unit in Israel.

1968-69 - Headed International Team under the auspices of the "Children's Medical Relief International", and established a hospital for Plastic and Maxillofacial Surgery for children, Saigon, during the Vietnam War.

Appointed Professor of Surgery and Incumbent of the Chair of Plastic Surgery, Tel-Aviv University, Medical School.

1972 - Co-developed the Sharplan Laser (Sharon and Kaplan), and embarked on CO2 Laser Surgery. Since then engaged in medical laser research and development of medical lasers instruments, and accessories.

1975 - Founded the International Society for Laser Surgery and Medicine, and served as President until 1979.

Founded the Israeli Society of laser Surgery and Medicine and served as President until 1995.

1975 - Received the Christian Johann Berger Award, Denmark.


1986 - Received Rothschild Prize for Innovation, Israel.

1989 - Visiting Professor, The National University of Cordova (Argentina).

1991 - Received the Diffenbach Award for Plastic Surgery.

1993 - Visiting Professor of University of Ascuncion., Paraguay.

1994 - Honorary Professor of Post Graduate Medical School, Beijing, China.

1995 - Honorary Professor of the National University of Cordova (Argentina).

1999 - "Investigator, Collaborator" of the Ministry of Science and technology of Cuba.

1999 - William B. Mark memorial award (USA)

2000 - Academic Award of Excellence (S. A. Zionist Federation), Israel.

2001 - Honorary Professor of the Sri Ramachandra medical college (India).

2001 - Honorary President of the world Federation of Societies for Laser Medicine and Surgery.

2006 - Honorary President of the International Society of Phototherapy.

Published over 200 Professional Articles; 2 Books on Plastic Surgery; 4 Books on Laser Surgery and several chapers in other books on Lasers in Medicine and
Surgery.

Honorary Member of the following societies

4. International Society for Laser Surgery and Medicine (Founder and Hon. President).
5. Israel Society for Lasers in Dentistry (Hon. President).
8. The Latin America Society for Laser in Medicine and Surgery (Hon. President).
17. The European Laser Association.
18. The National Surgical Society of Cuba.
20. The Laser Society of Mar-Del -Plata.
21. The Greek Laser society
24. The World Federation of Laser Medical Societies (Hon. President).
NEW THERAPEUTICAL EFFECTS OF LOW LEVEL LASERS AND CLINICAL APPLICATION IN DENTAL AND ORAL SURGERY

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The mW level low power lasers, GaAlAs diode lasers, He-Ne laser and argon dye laser have been applied to the author’s clinical and experimental studies. As the results, the following interesting effects have been newly found in addition to previously recognized effects such as anti inflammatory effect, wound healing activation effect, analgesic effect:

1) The unique effects in the diode laser: ① Depigmentation effect on melanous nevi of a mucosa, ② Therapeutic effect for trismus in TMJ troubles and ③ Improvement the saliva function in its restricted disease of Sjogren’s syndrome.
2) The unique effect in He-Ne laser: Therapeutic effect of the vasculargenous red colored lesions.
3) Common effect to the diode laser and He-Ne laser: Bone repaire activation effect.
4) Effect of argon dye laser: Reactive secondary dentin formation effect under the premedication of HpD. The effect under 1)~3) have been successfully applied in the author's clinic.

Methods and Laser Devices Used

The laser devices used are as follows
1) A gallium-aluminum-arsenide (GaAlAs) diode laser: wavelength 790 nm, with selectable output powers of 10, 20, and 40 mW, continuous wave (CW); (2) A GaAlAs diode laser: wavelength 830 nm, with selectable output powers of 20, 40, and 77 mW, CW; (3) a helium-neon (HeNe) laser: wavelength 632.8 nm, maximum output 6 mW, CW or frequency modulated (‘pulsed’) emission at 10 Hz; and (4) An argon dye (Ar-dye) laser: wavelength 630 nm, maximum output 150 mW.

The lasers were all aimed directly at the surface of the lesion. In the case of both the 790 nm and 830 nm GaAlAs diode lasers, the beams were focused onto the tissue from a handheld whereas in the HeNe and AR-dye lasers, delivery was via a fiberoptic cable. Usually lasers were emitted in continuous wave mode at their respective maximum output but in pain attenuation using the HeNe laser, the beam was frequency modulated at 10 Hz.

Patients were chosen on the basis of having multiple lesions or symptoms. A single lesion or symptom was chosen from a patient and treatment was limited to one modality in order to gain data as objectively as possible.

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Therapeutic Effect

From the treatment of approximately 500 cases with maxillo-oral diseases, several therapeutic effects for low-reactive level laser therapy (LLLT) have been previously reported, including anti-inflammatory effects; pain attenuation; enhanced wound healing in normal wounds; and healing of refractory ulcers.

To list examples relevant to the dental field, cases with refractory ulcerative stomatitis, glossodynia, and neuralgia-like pain, all of which were resistant to conventional treatment, resolved quickly following laser therapy with diode or HeNe lasers. The status of refractory ulcers in leukemic patients and post-dental extraction wound dehiscence in diabetic patients improved with HeNe laser treatment. HeNe laser therapy also demonstrated a hemostatic effect in hemorrhagic ulcers. The author would like to present further therapeutic effects of LLLT that he has discovered in clinical practice and experimental examinations.
1) **Therapeutic effect of diode lasers (3)**

(1) Restoration of temporal-mandibular joint function of patients with temporal mandibular joint arthropathy displaying trismus.

The painful area was treated with 10 mW LLLT for 5 minutes per session. Therapeutic effect was seen as early as after the second session. One month after 10 sessions the degree of mandibular opening improved from 25 mm to 45 mm (Fig. 1). The efficacy rate of this treatment is extremely high.

(2) Restoration of salivary gland function

Salivation from the parotid papilla was restored after 18 sessions in a Sjögren’s syndrome patient complaining of oral cavity dryness. Each session consisted of 5 min of percutaneous irradiation of 10 to 20 mW of diode laser to the parotid gland (Fig. 2). The course after treatment was satisfactory.

(3) Therapeutic effect on melanotic nevi of the oral mucosa

The color of a melanotic nevus of the oral mucosa resolved after only 10 mW, 20 min of laser irradiation to a small finger tip sized lesion. Further treatments with 20 mW and 40 mW devices displayed resolution of the lesion according to the laser energy with which the lesion was irradiated (Fig. 3).

2) **Therapeutic effect of He-Ne laser (4)**

Therapeutic effect on vascular anomalies

The HeNe laser used in the treatment of abnormally colored vascular lesions, such as red nevi, facial traumatic bruising and hemangiomas, caused resolution of the color after 4-5 minutes of 6 mW laser irradiation. A single treatment session started the resolution and after several treatments only the abnormally colored area had seen any changes (Fig. 4a, b). This effect was dramatic, and has been seen in several previous clinical experiences.

3) **Common therapeutic effects of the He-Ne and diode lasers**

Bone healing enhancement (5)

In patients having more than one tooth extracted, a single wound bed was treated with lasers while the others were not. Radiographic follow up revealed that both HeNe and diode lasers had a bone healing enhancement effect similar to that of YAG lasers (Fig. 5). This effect was confirmed in a rat femur bone healing model (Fig. 6).

4) **Reactive secondary dentin formation of the medulla following Ar–dye laser irradiation. (6)**

This phenomenon where secondary dentin formation occurs and successively replaces the whole medulla of the tooth, is seen after 5 J of argon or YAG laser irradiation. However this same phenomena also occurs after photodynamic therapy with 5 J of 150 mW Ar-dye laser irradiation of rats premedicated with hematoporphyrin derivative (HpD) (Fig. 7).

5) **Other effects**

Other effects, including enhanced bone healing after...
MEMORIAL ARTICLE

YAG laser irradiation, can be considered as LLLT-mediated, since these effect are brought about by low incident levels of photon intensity in the target tissue, as the incident laser energy penetrates deeper into tissue. It can therefore be said that the pulsed CO2 laser irradiation method that the author has devised could be considered as an LLLT application for similar reasons.

Discussion

In order to increase therapeutic effect of LLLT systems there always remains the question on how to deliver as much laser energy to the lesion as possible. One way to solve this problem is to build devices with higher output powers. To power up diode laser LLLT, it is possible to use the simultaneous output from multiple laser diodes or use a single laser diode with a higher output power.
output power. The latter is easily recognizable as the ideal solution, however such diodes are much more prone to damage. Fig. 8 displays the relative loss of laser energy in the case of HeNe and diode lasers according to tissue depth. In LLLT the key factor is how to administer laser energy to the lesion most effectively. One method is the contact method devised by Nagasawa and Kato in 1991, based on the approach previously pioneered by Ohshiro in 1989.

By pressing the laser head against the surface of the lesion, laser energy can be delivered with less absorption by the tissue in between the target cells and the handpiece. This was proven in the treatment of nevi using the diode laser.

Treatment of the abnormal red color of vascular group anomaly lesions with the HeNe laser often results in slight blanching of the irradiated area. Animal models have shown that temporary vasoconstriction occurs after HeNe laser is irradiated. This phenomenon, believed to be of induced sympathetic hypertension, may be of help in the further elucidation of the mechanism on how the HeNe laser resolves reddish vascular lesions.

The enhancement of bone healing of lasers is

| Table. 1 |  |
|---|---|---|---|
| **Dry weight (mg)** | **Ashed weight (mg)** | **Ca (mg)** | **P (mg)** |
| Control | Fig. 9-1 | 11.60 | 4.02 | 0.86 | 1.04 |
| GaAlAs L. (830 nm) | Fig. 9-2 | 14.24 | 5.39 | 1.28 | 1.24 |
| GaAlAs L. (790 nm) | Fig. 9-3 | 12.52 | 4.76 | 1.00 | 1.14 |
| He-Ne L. (632 nm) | Fig. 9-4 | 13.98 | 5.16 | 1.04 | 1.22 |
thought to be activation of bone formation through bone growth factor (BMP) (Fig. 9, table. 1). Reactive secondary dentin formation is seen a non-photothermal reaction associated with PDT using HpD and the Ar-dye laser. At this time, one can speculate that there is a photodynamic reaction aside from the thermal effect of lasers.

In laser treatment, laser light-tissue interaction must be assessed three dimensionally. However, many neglect this fact and use the laser based on guesswork. When visible light lasers are used, tissue distribution of the incident beam may be observed. However when lasers outside of the visible spectrum are used this becomes impossible. The charge-coupled device (CCD) image sensor chip is sensitive to near infra-red light and has recently caught the attention of the author. The author is studying the use of CCD cameras for the imaging of intra-tissue laser light distribution. This method will be invaluable for the monitoring of near infra-red laser light distribution during laser treatment (Fig. 10). The author is considering laser densitography using CCD cameras using its high resolution at the near infra-red wavelengths (Fig. 11).

Fig. 12 displays the relative intra-tissue intensity distribution of YAG lasers. Even when high output laser treatment is performed, the attenuated laser ener-
gy may be associated with an actual therapeutic effect (as in bone repair enhancement). The difference of laser tissue interaction among different tissues is demonstrated by the absorption of lasers of the respective tissues.\(^{(11)}\) This is calculated as a function of difference of laser light intensities. However it is very difficult actually to calculate this for living tissue, whose optic characteristics are extremely complex. Intra-tissue laser absorbance can equally be replaced with thermal changes. Since photothermal reaction is radiant, any thermal sensor placed on tissue must avoid any direct effect from the incident laser beam in order to measure tissue temperature changes correctly. The author has developed a special thermocouple with the sensory tip coated with highly reflective substances to laser light. The author is using this thermal couple in combination with radiation thermometry and real time thermography to develop a laser irradiation tissue thermo-monitoring system (Fig. 13). However when using low output lasers, one must use the microthermal measurement method developed by the author.\(^{(12)}\)

Conclusions

The author has discovered the following new therapeutic effects associated with laser therapy systems, and other low output lasers.

\(\text{(GaAlAs diode laser)}\)
1. Therapeutic effect on trismus
2. Improvement of salivary gland function
3. Resolution of color of oral mucosal nevi\(\text{(HeNe laser)}\)
4. Resolution of color of vascular reddish lesion\(\text{(He-Ne and diode lasers)}\)
5. Enhancement of bone healing\(\text{(PDT using HpD + Ar-dye laser)}\)
6. Reactive secondary dentin formation

The author has also developed several types of hardware associated with laser therapy in dental and oral surgical applications, and these are expected to help the further development of LLLT.

Acknowledgement

This paper was translated and reproduced with the permission of Mrs. Nagasawa, wife of the late Dr. Akinori Nagasawa (1935-2002).

References

Laser Therapy is once more in regular publication, after a gap of some 4 years without an issue being regularly published. With the eight issues that have appeared, Volume 14 No.1~4, Volume 15 No.1~4, Volume 16 No.1 we are confident that the journal will once again represent the best and most state-of-the-art scientific and clinical concepts on phototherapy and photobiomodulation.

The direct subscription rate to the journal for individuals and institutions will be JPY ¥26,000, the same as the previous rate in 1998. There will be further discounts for bulk subscriptions from agencies world wide. For details, please contact the Laser Therapy Business Manager by any of the following:

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American Society for Laser Medicine and Surgery (ASLMS)
Date: 4/11 to 15/2007
Cite: Grapevine, Texas, USA
Congress Chairman: Kristen M. Kelly
President: A. Jay Burns
Secretary: J. Stuart Nelson
Web address: http://www.aslms.org/
Message from association:
We Are Only Two Months Away From The Annual Conference In Grapevine, Texas! Kristen M. Kelly, M.D.
As I highlighted in previous Newsletter columns, we are excited to introduce a new course entitled, “How Can We Use Diagnostic Information”. This course will be a forum for clinicians, scientists, engineers and industry representatives to discuss the information content afforded by optical diagnostics as well as application and optimization of these technologies. There will be ample opportunity for discussion and interaction during this course, which will be offered free to residents and fellows in training. (to be continued to website)

British Medical Laser Association (BMLA)
Date: 6/7 to 8/2007
Cite: Liverpool, UK
Congress Chairman: Caroline Sudworth
President: Harry Moseleys
Secretary: Caroline Sudworth
Web address: http://www.bmla.co.uk/
Message from association:
2007 Annual Meeting and AGM, Museum of Science and Industry in Manchester 7th and 8th June 2007
We are pleased to announce the first details of the BMLA Annual Meeting and AGM to be held in June 2007 in Manchester, UK. This is an ideal opportunity to meet with others working in your field, to broaden your knowledge and undertake training. This year we are continuing to offer training courses in combination with parallel conference sessions. (to be continued to website)

Japan Photodynamic Association (JPA)
Date: 6/16 to 17/2007
Cite: Tochigi, Japan
Congress Chairman: Tetsuya Nakamura
President: Harubumi Kato
Web address: http://square.umin.ac.jp/jpa/
Message from association:
The Japan Photodynamic Association (JPA) started as Japan Chapter of The International Photodynamic Association. The first congress is hosted by Prof Yoshihiro Souda, Tokyo Medical University. This 17th Congress theme is “Diagnosis and treatment in Light Century”. (to be continued to website)

Japan Laser Therapy Association (JaLTA)
Date: 6/30 to 7/1/2007
Cite: Tokyo, Japan
Congress Chairman: Kazuhiro Mizutani
Secretary General: Masahito Kawatani
Web address: http://square.umin.ac.jp/jalta/
Message from association:
Theme is “EBM and future of Laser Treatment”. (to be continued to website)

Japanese Association for Nd:YAG Laser Dentists (JANLD)
Date: 7/21 to 22/2007
Cite: Kobe, Japan
Congress Chairman: Takahide Komori
President: Koukichi Matsumoto
Secretary General: Yoshio Kato, Masahiro Hirata

Japan Association for CO2 Laser Dentists (JACLD)
Date: 7/21 to 22/2007
Cite: Kobe, Japan
Congress Chairman: Takahide Komori
President: Koukichi Matsumoto
Secretary General: Yoshiio Kato, Masahiro Hirata

Japan Society for Laser Surgery and Medicine (JSLSM)
Date: 9/14 to 15/2007
Cite: Asahikawa, Japan
Congress Chairman: Shinichi Kasai
President: Harubumi Kato
Web address: http://www.jslsm.com/
Message from association:
This 28th Congress theme is “Challenge for state-of-
the-art medical treatment of light”. We hope fruitful discussion on the present medical laser should be carried out. There will provide safety education seminar to aim expanding laser medical specialist. (to be continued to website)

**European Medical Laser Association (EMLA)**
Date: 11/20 to 22/ 2007  
Cite: Prague 1, Czech Republic  
Message from association:  
**Laser Prague 2007**  
(11TH INTERNATIONAL JOINT EMLA AND WALT LASER CONGRESS)  
Main Topic: Convergency of surgical and therapeutic lasers - future or present issue?  
(to be continued to website)

**Japanese Association for Laser and Sports Medicine (JALSM)**
Date: 10/2007 (No definite dates yet)  
Cite: Nagano, Japan  
Congress Chairman: Yoshimi Asagai  

**International Society for Laser Surgery & Medicine (ISLSM)**
Date: 11/8 to10/2007  
Cite: Firenze, Italy  
Congress Chairman: Leonald Longo  
President: Harubumi Kato  
Secretary General: Abraham M. Baruchin  
Web address: [http://www.laserflorence.org/yearsMeeting.htm](http://www.laserflorence.org/yearsMeeting.htm)  
Message from association:  
**Laser Florence**  
Date: 11/8 to10/2007  
Cite: Firenze, Italy  
President: Leonald Longo  
Web address: [http://www.laserflorence.org/about.htm](http://www.laserflorence.org/about.htm)  
Message from association:  
**The Renaissance of Art, Science & Friendship**  
Leonardo Longo  
The series of courses and Laser Florence congresses started in 1997 with three objectives:  
• to increase the number of physicians, engineers and scientists who correctly use lasers in medicine, surgery and human sciences  
• to facilitate the exchange of theoretical and practical experiences between different world wide schools of human sciences and medicine through discussion and demonstration  
• to foster contacts between industry, engineering, physics, medicine and surgery. (to be continued to website)

**Antoni De Gimbernat Foundation**
Date: 11/9 to11/2007  
Cite: Cambrils(Tarragona), Spain  
Chairman: Mario Trelles  
Message from association:  
**ANTONI DE GIMBERNAT FOUNDATION GRANT 2007**  
**Mario Trelles**  
This year’s course in Vilafortuny on the subject of “Aesthetics, Dermatology, Vascular and Incisional Surgery with Lasers”  
The ANTONI DE GIMBER-NAT FOUNDATION, located at the Instituto Médico Vilafortuny (Cambrils, Spain), was founded in 1990 with the board of trustees integrated by the several Governmental Institutions such as the Town Hall of Cambrils, the County Council of Tarragona, The Medical Sciences Academy of Tarragona, and the Department of Morphologic Sciences (Medical Faculty of the University of Valencia) in Spain, with the main aim of carrying out work of social interest, to improve health and the quality of life through research. (to be continued to website)

**International Association of Dental Traumatology (IADT)**
Date: 1/12 to 14/2008  
Cite: Nagoya, Japan  
Congress Chairman: Mitsuhiro Tsukiboshi  
President: Marie Therese Flores  
Secretary General: Mitsuhiro Tsukiboshi  
Web address: [http://www.iadt-dentaltrauma.org/web/](http://www.iadt-dentaltrauma.org/web/)  
Message from association:  
**XV World Congress on Dental Traumatology**  
January 12-14, 2008  
**Mitsuhiro Tsukiboshi, Program Chairman and President-Elect**  
It is my privilege, on behalf of International Association of Dental Traumatology, to invite you to the 15th World Congress on Dental Traumatology in Nagoya.  
Nagoya is the third largest city in Japan. It takes 2 hours to travel by bullet train from Tokyo and 35 minutes from Kyoto, the world famous historical place. Among the best sight-seeing places in Nagoya is Tokugawa Art Museum with its outstanding history of Shogun. Mt. Fuji which you can see in the picture
above, is located nearby. (to be continued to website)

World Association for Laser Therapy (WALT)
Date: Will soon be announced on the web site.
Cite: Sun city, South Africa
Congress Chairman: Heidi Abrahamse
President: Farouk al-Watban
Secretary General: Tony Pinheiro
Web address: http://www.walt.nu/
Message from association:
South Africa Will Host WALT 2008
The Executive Council has chosen South Africa as the venue for WALT 2008. The Laser Research Group in the Faculty of Health Sciences at the University of Johannesburg focuses on Phototherapy using low powered lasers for the treatment of medical conditions including cancer and wound healing.
(to be continued to website)

International Society for Lasers in Dentistry (ISLD)
Date: 7/26 to 28/2008
Cite: Hong Kong
Congress Chairman: Jonny Wong
President: Samir Namour
Secretary General: Aldo Brugnera
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**Name as it appears on the card:** ..................................................  
**Card Number:** .................................................................  
**Expiry date:** *(Month) ............. (Year) ............. 3-digit security number .............  
**Cardholder’s signature:** .................................................. **Date:** ......................

**2: International Postal Money Order**
*(can be ordered at any major Post Office. When you choose this method, please let us know. All fees should be paid by sender.)*
Money order for **JPY ¥12,000 (Charter Member) / ¥120,000 (Life Member)** *(delete incorrect amount)* to be in favour of **IPTA**, and sent with this form by airmail to: **IPTA Treasurer**, c/o Japan Medical Laser Laboratory, 4F Shinseki Kaikan Bldg., 33-2 Shinanomachi, Shinjuku, Tokyo, Japan 160-0016

**Note1:** If your nation’s post office doesn’t deal with yen-based, we can accept yen equivalent money order.  
**Note2:** Please pay attention “International Postal Money Order” and Postal Money Order is different. Postal Money Order is not acceptable.