

## ENDOSCOPIC Nd-YAG LASER THERAPY IN UPPER GASTROINTESTINAL TRACT

BY

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### ABSTRACT

Forty-seven patients with gastrointestinal bleeding, benign tumor and malignancy were treated by YAG-laser therapy from 1980 to 1987. For active bleeding, laser coagulation was effective in inducing hemostasis. This therapy was also effective for the potential bleeding lesions. Benign sessile lesions such as polyp and adenoma were completely treated by laser vaporization. In cases with malignancy, the small-sized early gastric cancer (less than 15 mm in diameter) could be effectively treated. Among them, one case was followed up for as long as 82 months without any sign of recurrence. On the other hand, poor results were obtained in the cases suffering from early esophageal cancer due to incomplete laser irradiation resulting from the fear of penetration through the thin-walled esophageal mucosa. However, for the malignant stricture, the laser therapy was useful to relieve the lesion due to the regression of the tumor size. After the treatment, the patient was able to take meals orally. The above data demonstrate that the laser therapy is useful for the treatment of bleeding, sessile lesions, small-sized early gastric cancers and malignant strictures induced by advanced cancer.

Key words:

### INTRODUCTION

The endoscopic laser therapy was introduced for the treatment of gastrointestinal diseases since 1975. As being applied in clinical use, this therapy has been pointed out to be useful for gastrointestinal bleeding, protruding lesions and malignancies (Kiefhaber *et al.* [1]; Kuyama *et al.* [2, 3]). However, the utility and indication of laser therapy has not been well established. To confirm the effectiveness of the therapy for the above lesions and to establish the indications for the therapy, we reviewed the results of the Nd-YAG laser therapy in 47 cases who received Nd-YAG laser therapy in our department for the past 8 years.

### PATIENTS

Forty-seven patients, admitted to our department from 1980 to 1987, received endoscopic Nd-YAG laser therapy for the treatment of the upper gastrointestinal diseases. The diagnosis was based on the endoscopic findings and/or histopathology of the biopsied specimens. The classification of the lesions is shown in Table 1.

Emergency endoscopy revealed active bleeding from gastric ulcer in five patients with acute gastrointestinal bleeding. The laser coagulation was successful in four cases, while it was not effective in the other one case. This case needed surgical procedure to ligate the feeding arteries for hemostasis. Hemorrhage was mostly due

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Table 1. Patients Characteristics

GI bleeding .....	5
Benign tumor	
Hyperplastic polyp	
II.....	15
III.....	6
IV.....	3
Adenoma.....	2
Malignancy	
Early esophageal cancer.....	1
Advanced esophageal cancer.....	2
Early gastric cancer.....	11
Advanced gastric cancer.....	2

to the drugs, in particular anti-inflammatory drugs.

Twenty-six patients with benign tumor of the stomach were treated with laser (14 males, 12 females; median age 61 years). Among them, 24 patients were diagnosed as having hyperplastic polyps: 15 patients had type II polyp by Yamada's classification, six had type III and three had type IV. There were some patients having plural polyps. Two patients were suffering from gastric adenoma. These polyps or adenoma were smaller than 15 mm in diameter.

Sixteen cases (15 males, one female; median age 70 years old) suffering from malignancies received Nd-YAG laser therapy. Eleven cases had early gastric cancer, two advanced gastric cancer, one early esophageal cancer and two advanced esophageal cancer. Both physical and laboratory examinations including barium swallow, panendoscopy, computerized tomography were carried out to check the complication and distant metastases. These patients did not receive surgical therapy because of the association with other neoplasms or unwilling to undergo surgery. The Nd-YAG laser therapy was aimed at curing completely the small-sized lesions. But, in the cases of large-sized lesions, regression of the tumor size or recanalization of the malignant stricture

was the main purpose.

#### METHODS

We used YAG-Medical 100 and 101 (CILAS Co. Ltd., France) and one-or two-channel flexible, fiberoptic endoscope (Olympus GIF-Q, GIF-2T) with a quartz wave guide inserted through the biopsy channel. By the non-contact method, coaxial carbon dioxide or air flow within the quartz wave guide kept the tip cool and free of debris; the rate of flow was generally limited to about 4 L/min to avoid insufflation of a large volume of gas into the stomach. Frequent suction of gas from the stomach were inevitably needed. But, by the contact method, this probe has a merit that the air flow is not needed to cool the tip, so the patient is not annoyed by insufflation of a large volume of gas into the stomach. Each laser treatment was performed under endoscopic direct vision after topical anesthesia with xylocaine and use of an anticholinergic drug.

We used the technique by Fleischer and Kessler [4], with minor modifications. Briefly, by varying the pulse duration of 0.5 to 2 seconds and by maintaining the power output at 50 W per second, various energy densities could be evolved in the tissue. By the non-contact method, the distance from the tip to the target was kept to about 1 cm.

For hemostasis, the energy densities up to 1000 J/cm<sup>2</sup> led to coagulation. The radiation was initially done on the area surrounding the bleeding vessel to induce edema and to occlude the feeding vessels, thereafter the bleeding source itself could be occluded with safety.

For benign and malignant tumors, the energy densities of more than 1000 J/cm<sup>2</sup> were needed for vaporization. In the pedunculated lesions, the stalk was irradiated with a pulse duration of 2 seconds, because such lesions were generally white-

colored and difficult to carbonize. In the sessile lesions such as polyp, adenoma and early cancer, the pulse duration of 1 second was employed. With careful vaporization, the lesion was irradiated until it became flattened. In tumor obstruction, recanalization was the goal of laser therapy to maintain the physiological means for nutrition. Repeated palliative irradiation to reduce the mass of the tumors was carefully performed to avoid complications such as perforation.

## RESULTS

### I. Gastrointestinal bleeding

Four out of five patients with active bleeding were cured successfully by laser coagulation, but one case failed in hemostasis. The unsuccessfully treated case received surgery to ligate the feeding arteries.

Emergency endoscopic examination was carried out for the patients suffering from gastrointestinal bleeding other than the above five cases, but did not confirm the active bleeding site. Among these cases, there were some cases in which the eroded vessel was found in the ulcer floor. Such potential bleeding lesions were irradiated with laser coagulation to prevent re-bleeding. The results of this treatment was excellent. There was no re-bleeding in the case receiving preventive laser coagulation.

### II. Benign tumor

The stalk of the pedunculated polyp was cut by laser vaporization. The resected polyp was picked up by a snare and examined histopathologically. The bleeding from the cut surface was easily controlled by laser coagulation. The sessile lesion which could not be resected by the snare was treated by vaporization. Disappearance of the tumor tissue was complete and no recurrence has been found.

### III. Malignancy

#### A. Early gastric cancer

The clinical data of 11 patients treated for early gastric cancer by laser vaporization are listed in Table 2. Two cases treated by laser radiation before the scheduled operation were excluded from this study. We defined "remission" as the condition impossible to find the cancerous lesion from the endoscopic appearance and biopsied specimens. Six cases (No. 1 to 6) were followed as remission. Among them, three cases (No. 4 to 6) died of other than cancer. The remaining three cases (No. 7 to 9), suffering from the relapse of gastric cancer, turned to be positive on gastric mucosal biopsy under observation. In these cases, one case (No. 7) died of gastric cancer. The relationship between the tumor size and remission duration is shown in Fig. 1. The lesions of all cases following the remission after the initial therapy were less than 20 mm in diameter. But, in No. 9, relapse after laser treatment was found despite the size being less than 20 mm. In this case, we had a chance to examine the histopathology of the irradiated stomach by autopsy. Microscopically, the tissues from the mucosa to the muscle layer were replaced by scar due to laser vaporization and no cancer cells were found. However, abundant cancer cells were found in the subserosal layer. The invasion of the submucosal layer by the cancer cells had been speculated by the endoscopic findings before treatment. The laser treatment might have spread the cancer cells. Therefore, we consider that lesions less than 15 mm could be effectively treated.

Patient No. 1 has been successfully followed up for as long as 82 months without any sign of recurrence. This 69-year-old man had early gastric cancer (type IIa, 7 mm in diameter) in the middle part of the body (Fig. 2). Because the patient had suffered from frequent attacks of angina

Table 2. Clinical Data of Patients with Early Gastric Cancer

No.	Age	Sex	Type	Size	Complication	Course
1	69	M	IIa	7	Angina pectoris	Remission for 82M
2	77	M	IIa	10	Cancer of the urinary bladder	Remission for 19M
3	74	F	IIC	5	Patient's refusal	Remission for 5M
4	79	M	IIa	15	Lung cancer	Remission for 56M →died of lung cancer
5	78	M	I	15	Liver cirrhosis	Remission for 12M →died of liver cirrhosis
6	76	M	IIC	20	Chronic renal failure	Remission for 6M →died of cancer of the gallbladder
7	79	M	IIC	50	Lung fibrosis	Relapse after 13M →retreatment →followed for 48M →died of advanced gastric cancer
8	72	M	IIa	20	Angina pectoris	Relapse after 12M →retreatment →remission for 52M →died of myocardial infarction
9	72	M	IIa	17	Liver cirrhosis	Relapse after 2M →retreatment →followed for 3M →died of liver cirrhosis
10	69	M	I	15		Operation
11	66	M	IIC	7		Operation

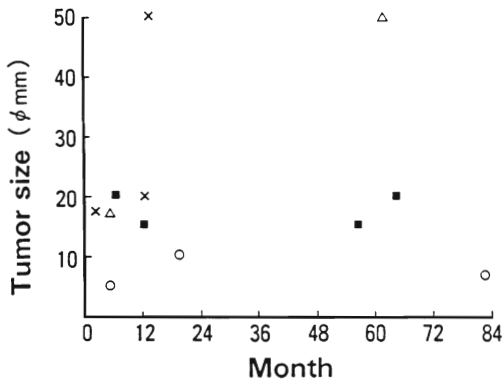
pectoris, surgery was not indicated. So, 40 shots of laser vaporization using the non-contact method were done with an output of 50 W per second. Thereafter, the biopsy from the lesion turned to be negative. After the laser therapy, scar is formed and there is no recurrence endoscopically (Fig. 3). Further follow-up must be required.

We used the contact method for patient No. 2. The patient had early gastric cancer (type IIa, 10 mm in diameter) in the upper part of the body (Fig. 4) and was complicated by the cancer of the urinary bladder. There was no difference in efficiency

between the contact and non-contact method (Fig. 5). This case was followed for 19 months as remission.

#### B. Early esophageal cancer

Poor results were obtained from the early esophageal cancer case. The 72-year-old man had surgical interventions twice: first, due to lung cancer and second for gastric cancer. At this time, he was found to have early esophageal cancer (type IIC) of the lower esophagus. The patient refused the third surgical intervention. So, cobalt radiation therapy was done for the lesion but the results of biopsy was not



○ : remission (survival case), ■ : remission, but dead other than cancer, △ : dead after relapse (no remission), × : relapse

Fig. 1. Relationship between the tumor size and remission duration in cases with early gastric cancer

negative. Although we can now use the argon dye laser, we had no chance to use it at that time. Therefore, we did laser irradiation three times. We carefully irradiated the depressed lesion with an output of 50–70 W in one-half second. The results of biopsy remained negative for six months after the laser treatment. But, because it changed to positive, we did cobalt radiation again. After that, he has been followed up at our outpatient clinic

for 38 months. In this case, the poor results seemed to be obtained from the esophageal ulcerative lesions due to incomplete laser irradiation resulting from the fear of penetration through the thin-walled esophageal mucosa.

C. Advanced cancer

Against the advanced cancer, it was not expected to cure the entire cancer lesions. The main purpose of the therapy was palliative treatment. Especially, the problem is the malignant stricture which causes malnutrition and aspiration pneumonia. We tried to relieve the lesions with the regression of tumor size by laser vaporization. We showed a successfully treated case in such a sense. A 78-year-old man was admitted complaining of dysphagia. The stenotic lesion due to cancer invasion was found in the lower esophagus by endoscopy (Fig. 6). Because of his old age, poor general condition and liver metastases, we did laser therapy twice, 50 shots at first and 70 shots the second time, with an output of 50 W per second. After treatment, the tumor decreased in size remarkably (Fig. 7). The patient was able to take meals orally and the passage of the endoscopy

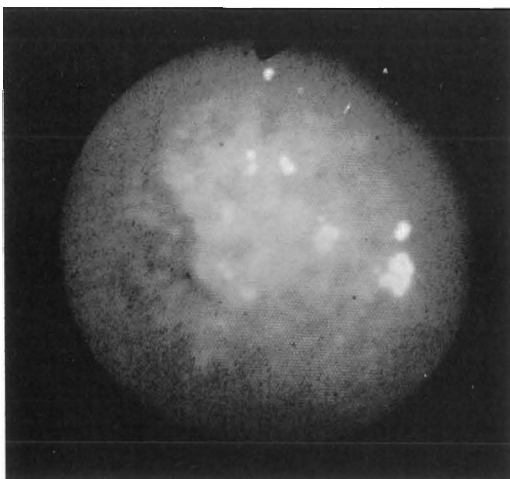


Fig. 2. Early gastric cancer (type IIa, 7 mm in diameter) is located in the middle part of the body

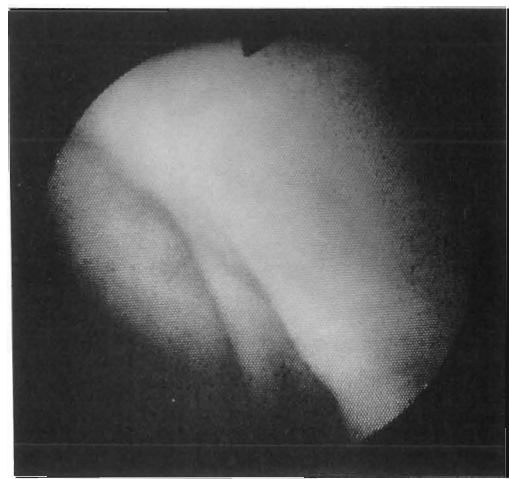


Fig. 3. The scar is formed by laser vaporization using non-contact method. There is no sign of relapse after 82 months from initial therapy

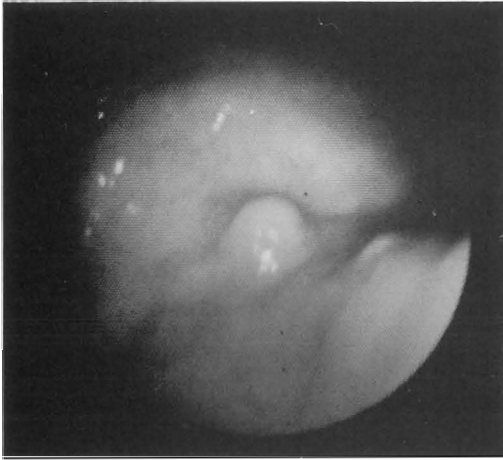


Fig. 4. Early gastric cancer (type IIa, 10 mm in diameter) is situated in the upper part of the stomach

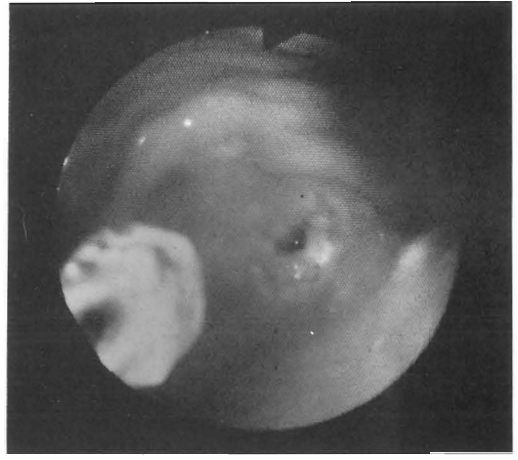


Fig. 5. The lesion was treated by laser vaporization using contact method



Fig. 6. Malignant stricture was found in the lower esophagus.



Fig. 7. Recanalization was accomplished by 6000 J/cm<sup>2</sup> of laser vaporization

became smooth through the esophagus and into the stomach.

#### DISCUSSION

The laser coagulation therapy for the lesions in gastrointestinal tract was introduced by Fruehmorgen *et al.* [5] in 1975. Since then, this technique has been widely distributed and utilized against the various lesions in the gastrointestinal tract other than bleeding. Several reports (Fujimoto *et al.* [6, 7]) indicated the usefulness of the

endoscopic laser therapy.

In the present study, we reviewed 47 cases who received laser therapy for the gastrointestinal lesions to establish the indications for treatment.

Many endoscopic methods for treating gastrointestinal bleeding have been developed in recent years (Fleischer [8]). All forms of treatment assessed clinically are based on tissue coagulation induced either chemically or thermally. Among them, the Nd-YAG laser has been proved to be a

better treatment because of its higher power output and its lower absorption by the blood. In the present study, initial irradiation to the surrounding area of the target lesion improves the hemostatic effect of laser coagulation. The cause of the failure to hemostasis was the misinterpreting of the size of the eroded vessel. By Swain *et al.* [9], vessels with a diameter of more than 1 mm are difficult to seal using the currently available thermal methods, such as laser or electrocoagulation. As for preventive coagulation, this is an excellent method to prevent re-bleeding.

Laser treatment of adenomas has been reported by some authors (Mathus-Vliegen and Tytgat [10]; Sander and Poesl [11]). For the pedunculated lesion, we could not find the difference between the removal by the snares and the vaporization by laser in regard to the effectiveness of the treatment. Now, we guess that the pedunculated polyps of the gastrointestinal tract should be resected endoscopically by the snares. In contrast, the sessile lesions may be more suitable for laser vaporization. Sometimes, several sessions are necessary for removing the whole polyp, particularly widespread adenomas. But, the small polyps disappeared by a single shot.

A complete disappearance of the cancer lesion is the purpose of laser therapy for early cancer. As mentioned already in our successfully treated cases, the size of the lesions was mainly about less than 15 mm. Regarding the metastasis and the depth of the lesion, it is desirable that the cancer invasion is limited to the mucosa and the size is less than 10 mm in diameter. The judgment of width and depth of the cancer lesion is very important.

Many patients with malignant esophageal stricture are not curable at the time of diagnosis. In palliative therapy, the purpose is to relieve dysphagia, the most

uncomfortable complaint. If the lumen is obstructed, the patient may die of malnutrition and/or aspiration pneumonia. In 1983, Fleischer and Kessler [4] reported on the good results obtained from laser therapy of esophageal stenosis. Since then, laser therapy has been found to be very useful to relieve the lesion with regression of the tumor size against the stenosis induced by malignancy (Mathus-Vliegen and Tytgat [12]; Lightdale *et al.* [13]). Laser therapy has some advantages, such as no need of general anesthesia, possibility of repeated radiation against relapse and no prosthesis in the esophagus. We consider that endoscopic Nd-YAG laser therapy is a safe and useful means which improve the quality of life in the patients with unresectable, advanced carcinoma in the lower esophagus and/or cardia. However, the most critical limiting factor is that much experience and excellent skill in endoscopic technique are needed to safely apply this powerful tool. Ultimately, technical advances (e.g., photosensitizing agents, tunable wavelength lasers) may resolve this problem.

We believe that laser therapy may provide a suitable treatment for hemostasis, sessile lesions, small-sized early gastric cancers and malignant strictures induced by advanced cancer.

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