The Contact Laser in Gastroenterology: Past, Present and Future Perspectives*

STEPHEN N JOFFE, M Y SHANKAR, N DAIKUZONO

Department of Surgery, University of Cincinnati Medical Center, 231 Bethesda Avenue, Cincinnati, Ohio 45267-0558, USA

Abstract

Ninety-one patients have been successfully treated without complications using contact neodymium: YAG laser probes endoscopically for tumors and bleeding, and during open surgery (laser scalpel), for liver and pancreatic resections. The contact probes made from a synthetic sapphire crystal with its optical properties, geometric design, and thermal conductivity have proven to be more effective than the current conventional noncontact method of delivering laser energy through a quartz fiber. Advantages include greater precision, sterilizability, avoidance of the tip melting, and a requirement for lower neodymium:YAG laser energy with reduced tissue damage. The configuration of the probes allows coagulation, cutting, or vaporization, depending on the clinical condition being treated. Coaxial water or saline has proven to be safer and more effective than coaxial air for therapeutic endoscopy.

Key Words: Bleeding, contact surgery, peptic ulcers, esophageal carcinoma, Nd:YAG lasers, liver, pancreas, tumors.

Introduction

Applications of the neodymium:YAG laser in Gastroenterology have increased in the United States from being used in 12 centers in 1981 to being used in over 1,000 installations as of December, 1986. Sales of medical lasers are expected to reach $600 million by 1990 and between $1-2 billion and $2-5 billion by 1995. This continuing increase in the use of neodymium:YAG laser will account for most of these sales based on its multidisciplinary applications and increased endoscopic and therapeutic options. In major acute upper gastrointestinal (GI) bleeding, the neodymium:YAG laser has been found to decrease significantly the rebleeding rate and requirement for emergency surgery and to reduce mortality.

Results of a questionnaire presented in Washington, DC in April, 1985 found that 3,130 patients with acute upper GI bleeding (26 responders) and 987 patients with upper GI carcinoma predominantly of the esophagus (25 responders) have been treated endoscopically with the neodymium:YAG laser using the noncontact method.

Current neodymium:YAG laser light transmission systems use a flexible quartz fiber that delivers the laser energy at a distance of 0.5 to 1.5 cm from the tissue. This noncontact system has distinct disadvantages regarding beam irradiation and damage to the quartz tip should it come into contact with tissue or blood. Furthermore, the neodymium:YAG laser, because of its depth of penetration into tissue, is primarily used for coagulation but has poor cutting capabilities and may cause excessive tissue damage resulting in perforation.

The recently developed synthetic sapphire crystal, attached to the end of the quartz fiber using a universal metal connector, allows the contact laser energy delivery with ease. The geometric shape of these artificial sapphire provides the desired endoscopic effects of coagulation for bleeding and vaporization for excision of tumors. A longer probe allows for open surgery to be performed (laser scalpel) (Fig 1). The power density (W/cm²) is directly related to the distance of the probe from tissue (Fig 2). These contact probes prevent the backscattering of neodymium:YAG laser light, reduce the depth of tissue damage, and allow for much lower powers of laser energy to be used (Fig 3). This article presents the early results of contact neodymium:YAG laser surgery for gastrointestinal diseases.

Patients and Methods

Of the 91 patients (43 men, 48 women; average age 65-6 years) treated at the University of Cincinnati Medical Center, 71 underwent therapeutic endoscopic procedures and 20 by open operation using the contact neodymium:YAG laser system (Fig 4).

Fig 1: Laser scalpels with synthetic sapphire for coagulation, vaporization and excision.
The patients with bleeding were all admitted with hypotension, required a transfusion of more than 3 pints of blood and were shown at endoscopy to have an actively bleeding lesion or stigmata of a recent bleed.

Discussion

The contact method of performing endoscopic procedures and open surgery with the neodymium:YAG laser opens a new era in laser surgery. Conventional non-contact delivery of neodymium:YAG laser surgery is time consuming, requires high powers of laser energy (70-90 watts), cannot be performed with sterile delivery systems and is associated with excessive smoke production. Furthermore, the major problems of the tips of the fibers melting and burning off when in contact with blood or tissue has been totally eliminated using the contact synthetic sapphire probes. The use of coaxial water rather than gas is most useful. Previous experimental work with liver resection has indicated that the non-contact method of neodymium:YAG laser surgery results in tissue necrosis for distances of 3-5 mm, both deep as well as lateral to the area being treated. The contact laser scalpel is only associated with tissue damage 0.5-1 mm in depth (Fig. 3). Contact probes combine the coagulating properties of the neodymium:YAG laser with cutting capabilities previously seen only with the CO₂ laser. Contact neodymium:YAG laser surgery is rapidly extending into other specialties including urology, plastic surgery, neurosurgery, gynecology, and pulmonary and cardiovascular surgery. This therapeutic modality will offer cost containment in the current health care industry. The basic price of the laser itself is being reduced and portable lasers are now becoming available for easier electrical installation with avoidance of special cooling systems.
Table: Clinical Conditions Treated by Contact Nd:YAG Laser Surgery

<table>
<thead>
<tr>
<th>GI bleeding</th>
<th>Tumors</th>
<th>Open (n=20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnosis</td>
<td>No</td>
<td>Diagnosis</td>
</tr>
<tr>
<td>Mallory-Weiss</td>
<td>2</td>
<td>Gastric ulcers</td>
</tr>
<tr>
<td>Esophageal varices</td>
<td>4</td>
<td>Duodenal ulcer</td>
</tr>
<tr>
<td>Gastric erosions</td>
<td>9</td>
<td>Gastric carcinoma</td>
</tr>
<tr>
<td>Angiodysplasia</td>
<td>13</td>
<td></td>
</tr>
</tbody>
</table>

The SLT contact laser system (CL60) (Fig 4) has been specially designed to provide stability at low power (Fig 5) for contact laser surgery either for open or endoscopic applications but can also be used for non-contact at laser powers of 60 watts in either the pulsed or continuous mode.

References: