Endoscopic methods for the treatment of nonvariceal upper gastrointestinal hemorrhage

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ABSTRACT: In the 1970s, diagnostic fibreoptic endoscopy became part of the standard practice for evaluation of gastrointestinal disease. In the 1980s, therapeutic fibreoptic endoscopy is emerging as standard therapy for many gastrointestinal diseases. As the already sophisticated technology continues to blossom, it promises to become even more a part of the management of an increasing number of gastroenterological problems. Endoscopy can provide both a specific diagnosis as well as an identification of the high risk subgroup of patients with either active bleeding, or a nonbleeding visible vessel that might benefit from endoscopic treatment. At endoscopy, patients with active ulcer bleeding have either arterial spurting, oozing or oozing beneath an overlying clot. These have poor outcomes: for example, when a nonbleeding visible vessel is identified, the chances for rebleeding are approximately 50% during the period of that hospitalization. With an overlying clot without oozing, where dark spots are noted, there is less than a 10% chance of rebleeding. There are certain limitations for endoscopic hemostatic therapy and there are a few bleeding ulcers with an artery too large to expect endoscopic success. The kind of treatment chosen will be dictated by the availability of the therapeutic modalities and the skill of the surgeon. **Can J Gastroenterol 1988;3(2):72-76**

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Méthodes endoscopiques et traitement de l'hémorragie non-variqueuse des voies gastrointestinales hautes

RESUME: Dans le diagnostic des années 1970, l'examen fibroscopique est devenu partie intégrale des pratiques d'évaluation des maladies gastrointestinales. Au cours de la décennie suivante, l'examen fibroscopique thérapeutique émerge comme la thérapie standard de nombreux désordre gastrointestinale. Au fur et à

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A MAJOR ADVANCE IN THE MANAGEment of gastroenterological problems has been in the treatment of patients with upper gastrointestinal tract bleeding. Recent reviews have considered the management of variceal hemorrhage. Various approaches to nonvariceal bleeding include tissue contact by electrocoagulation, both monopolar and bipolar electrodes or heater probes. A second approach, without tissue contact, consists of laser photocoagulation with either the argon or the neodynium: yttrium aluminum garnet (Nd:YAG) laser. The third approach is an injection therapy of known bleeding lesions with alcohol, sclerosants or adrenaline. All of these therapeutic methods are relatively safe and effective in controlling bleeding and avoiding emergency surgery.

LASER PHOTOCOAGULATION

In 1971, Goodale and co-workers (1) reported the first studies using a carbon dioxide laser to control bleeding lesions in animals. Currently the Nd:YAG and argon lasers are used to treat gastrointestinal bleeding. The relative merits of the Nd:YAG and argon lasers for the therapy of acute upper gastrointestinal bleeding are as follows: when applied endoscopically, both lasers effectively produce initial hemostasis in many pa-

mesure que la technologie d'avant garde progresse, cette pratique confirme la place qu'elle occupe dans le traitement de certains problèmes gastrointestinaux. Un progrès majeur a ainsi été réalisé dans le traitement des patients souffrant de saignements des voies gastrointestinales. Parmi les approches diverses, il faut inclure le contact tissulaire par électrocoagulation, qui comprend l'usage des électrodes unipolaires et bipolaires ou les sondes thermiques. La seconde approche sans contact avec les tissus consiste à utiliser la photocoagulation au laser argon ou Nd:YAG (dont le milieu actif est un cristal d'yttrium et d'aluminium dopé au néodyme). La troisième approche est une thérapie d'injections des lésions saignantes connues. Ces trois méthodes sont sûres et efficaces dans le traitement des hémorragies et elles permettent d'éviter les interventions d'urgence. L'endoscopie peut servir à la fois à établir un diagnostic précis et à identifier le sous-groupe de patients à haut risque qui ont des saignements actifs, ou à reconnaître les vaisseaux qui ne saignent pas mais qui bénéficieraient d'un traitement endoscopique. Au moment de l'endoscopie, les patients souffrant de saignements d'ulcères en évolution ont soit des giclements artériaux, des suitements, ou des suitements sous des caillots sus-jacents. Dans ces cas particuliers, les résultats sont médiocres. Par example, quand un vaisseau visible sans saignement est identifié, les chances de resaignements sont de 50% durant l'hospitalisation. Dans le cas d'un caillots sus-jacent sans suitement, où l'on remarque des taches sombres, il y a moins de 10% de possibilités de resaignement.

tients; the Nd:YAG laser is technically easier to use because distance from the bleeding lesion is not quite so critical and coaxial gas flow requires carbon dioxide in a noncontact mode; and the risk of perforation is theoretically less with the argon laser because the depth of tissue penetration is less. At present the Nd:YAG laser is used most commonly.

The principle of endoscopic lasers is the same as for all types of laser. There are atom molecules in a laser medium of liquid, gas or solid in a normal or grounded energy state. Thermal, electrical or optical energy gives a higher energy rate to atom molecules existing in the medium. The laser energy must be absorbed by the tissues to have any effect and each tissue has a particular absorption spectra, depending on the amount of tissue chromophores (hemoglobin, melanin, carotene, water, proteins). Once absorbed, laser light energy is converted into heat energy producing either coagulation, cutting or abrasion.

Wavelength, which varies in different types of laser, is important in the production of the tissue response. The argon laser admits energy through argon gas, producing light in the blue-green spectrum with a wavelength of 488 to 514 nm. The carbon dioxide laser admits energy in the middle of the infrared spectrum at 10,600 nm. Unfortunately, this has limited use in gastroenterology, primarily because of poor transmission of infrared light by optical fibres.

The Nd:YAG laser is the main form of laser treatment in gastroenterology. It produces infrared light with a wavelength of 1064 nm and has a greater ability to coagulate blood vessels. The Nd:YAG laser can be used in either a contact or noncontact mode, however, in practice there is no advantage of one technique over the other.

The first reports of endoscopic laser therapy in humans were from uncontrolled studies in the mid-1970s. In 1979, Kiefhaber (2) reviewed the entire international experience from 37 centres with laser therapy of upper gastrointestinal tract bleeding in 1729 patients. Successful initial hemostasis was achieved in 86% (range 70 to 100%) of 196 patients treated in seven centres with argon lasers and in 90% (range 74 to 100%) of 1533 patients treated at 31 centres with the Nd:YAG laser. The largest experience is that of Kiefhaber (2), from 1975 to 1982, 994 acute bleeding incidents in 625 patients were treated at his centre in Munich. All patients, ie, an unselected group, were considered. Lesions included varices, Mallory-Weiss tears, ulcers, erosions, vascular anomalies and tumours. The overall success rate of initial hemostasis was 94%. Kiefhaber claimed a reduced mortality for acute and chronic ulcer bleeding treated with laser as compared to the experience in Munich before laser therapy was available. However, this survey did not address the incidence of rebleeding, and this series of patients was not randomized. Reports of high success rates for laser therapy of upper gastrointestinal bleeding must be evaluated with the perspective that approximately 70% of all episodes are self-limited and resolve without specific therapy.

Of more recent studies evaluating Nd:YAG laser therapy for all bleeding from ulcers, several suggest that laser confers a benefit to the patient. However, some reports differ in their results and suggest no benefit. The study of Swain and colleagues (3) deserves a more detailed discussion. Of 465 patients with upper gastrointestinal bleeding, 232 had peptic ulcers and 147 of the ulcers were either bleeding or showed stigmata of recent hemorrhage. Of 122 patients included in the study, 62 were treated with Nd:YAG laser while 61 served as controls. In the laser treated group bleeding was more effectively controlled ($P<0.02$) and the mortality was less ($P<0.05$) than in the control group. In those patients with active bleeding from visible vessels, the laser group fared better.

Macleod and colleagues (4) reported that of 184 patients found at endoscopy to be bleeding from peptic ulcers, 20 were bleeding from arteries. Eight of these were allocated to placebo treatment and all later underwent emergency surgery for further hemorrhage. Of the 12 patients who underwent laser treatment, eight had surgery, but of these only one was still bleeding and actually required surgery. These differences were statistically significant. The authors concluded that laser treatment was a safe and effective method of reducing the incidence of further bleeding and emergency surgery but the technique was difficult and not applicable to all patients.

Halprin and co-authors (5) used Nd:YAG laser coagulation to treat 32 seriously ill patients with massive or prolonged gastrointestinal bleeding. An average of 7.5 units of blood was given prior to Nd:YAG laser treatment. Twenty patients showed no evidence of contin-

ued or recurrent bleeding after laser therapy, four patients rebled after 48 h, three patients rebled within 48 h, one patient continued to bleed despite the laser treatment but died of an unrelated cause, one patient required immediate surgery because of inability to control bleeding and one patient died several hours after control of the bleeding. Although six patients died within 10 weeks, no patients exsanguinated. Thus, Nd:YAG laser treatment was a useful modality for controlling severe gastrointestinal bleeding in the seriously ill patient.

In approximately 70% of otherwise healthy patients, upper gastrointestinal bleeding will stop spontaneously. However, in those patients with an identifiable bleeding vessel the likelihood of rebleeding or continued bleeding is as high as 90 to 100%. About 50% of nonbleeding visible vessels will later rebleed. Numerous studies have shown an increased mortality from upper gastrointestinal bleeding in the aged and in patients with above average transfusion requirements. These patients, as well as those with continued or recurrent bleeding, may be ideal candidates for Nd:YAG coagulation of bleeding sites.

However, some studies of Nd:YAG laser therapy suggest no benefit. For example, Krejs and co-workers (6) studied, over 43 months, 174 selected patients with either active bleeding (n = 32) or stigmata of recent bleeding (n = 142) due to peptic ulcers who were randomly assigned during endoscopy to either standard treatment with laser photocoagulation or therapy without photocoagulation. There was no significant difference in outcome between groups. Continued bleeding or rebleeding was observed in 22% of the laser treated group and in 20% of the control group. Urgent surgery was necessary in 16% of the laser treated patients and in 17% of the controls. Laser treated patients spent a mean of 41 h in the intensive care unit, compared with 32 h for control patients. The mean hospital stay was 12 days in the laser treated group and 11 days in the control group. One death occurred in each group.

When patients with active bleeding were analyzed separately, there was no significant difference in outcome between laser treated and control groups even though laser photocoagulation initially stopped active bleeding in 88% of cases. Among patients with visible vessels, rebleeding occurred in five of 14 (36%) who received laser treatment and two of 15 (13%) controls. Laser treatment precipitated bleeding in four patients and duodenal perforation in one. The authors concluded that Nd:YAG laser photocoagulation did not benefit patients with acute upper gastrointestinal bleeding from peptic ulcers. However, it should be emphasized that Krejs eliminated many patients who were hemodynamically unstable from the study, thereby drawing a major criticism of the paper.

The results of three argon studies are mixed (7-9) and argon lasers are seldom used at present.

ANGIODYSPLASIA

The routine use of fibreoptic endoscopy in the evaluation of upper gastrointestinal bleeding has demonstrated that angiodysplastic lesions in the upper tract may hemorrhage. Generally, bleeding from angiodysplastic lesions is self-limited but may be recurrent. If the bleeding lesion is within the reach of the endoscope, it is amenable to local therapy.

One of the several treatment modalities for angiodysplastic lesions is laser photocoagulation. There are several reports describing endoscopic obliteration and clinical benefit with both argon and Nd:YAG laser therapy. Waitman et al (10) treated 50 patients with argon laser therapy; 33 had complete cessation of bleeding with follow-up of six months to four years. The other 17 had markedly reduced bleeding. Bowers and Dixon (11) and Jensen and colleagues (9) reported decreased bleeding episodes and reduced transfusion requirements with argon laser therapy in patients with angiodysplasia and in a group with classical hereditary telangiectasia. Fleischer (12) reported similar benefits using the Nd:YAG laser. None of these studies included perforation as a complication.

Laser use is not free from problems. Commercially available lasers are expensive and the machines are not portable in the practical sense. Laser therapy is not free from risk, aside from usual risks and complications of endoscopy and anesthesia. Major complications related to laser use itself occur in approximately 4% of patients including perforation, fistula to other organs and bleeding.

ENDOSCOPIC ELECTROCOAGULATION

Endoscopic electrocoagulation appears to be an inexpensive, readily available technique for the control of massive bleeding. Endoscopic electrocoagulation may be performed using monopolar or bipolar electrodes, or by fulguration. Electrocoagulation results as current flows through tissue near the electrode, hitting and desiccating the tissue to form a layer broken down and condensed into a necrotic mass. With monopolar electrocoagulation, current flows through the patient into a ground plate. In bipolar electrocoagulation the current density is very concentrated at the bipolar electrotip because the tissue contact completes a circuit between two wires only a few millimetres apart. This limits the risk of injury, which reduces the risk of perforation.

Moreto and colleagues (13) reported efficacy of monopolar electrocoagulation in the treatment of bleeding gastric ulcers. In a controlled prospective fashion, the efficacy of monopolar electrocoagulation in the emergency treatment of bleeding gastric and stomal ulcers was studied in 37 patients: 16 underwent electrocoagulation while the remaining 21 were treated by conventional methods (control group). Hemorrhage recurred in only one (6.2%) of the patients in the electrocoagulation group, but bleeding recurred in 11 (52.4%) of the 21 control patients ($P<0.05$), with no significant difference in mortality of the two groups.

Goff (14) compared the efficacy of bipolar electrocoagulation with Nd:YAG laser photocoagulation for upper gastrointestinal bleeding lesions. The total study group included 33 patients with solitary, actively bleeding lesions, rebleeding lesions or a lesion containing a visible vessel in the upper gastrointestinal tract. The patients selected for this study were heavily weighted toward high risk groups for rebleeding. Altogether, 33 patients underwent 37 coagulation sessions; 19 of the patients were randomized (eight

laser, 11 bipolar). In the randomized group, 47.4% had no rebleeding after therapy (laser 37.5%, bipolar 54.5%, $P<0.1$). The 14 nonrandomized patients were primarily treated with bipolar coagulation because they were felt to be too unstable to transfer to the laser unit at University Hospital, 58.6% had no further bleeding. Eleven (33%) of the patients required surgery but no patient died from bleeding or complications related to the study. Thus, there was no significant difference in the frequency of rebleeding after endoscopic treatment of upper gastrointestinal hemorrhage from various sources, using either Nd:YAG laser photocoagulation or bipolar electrocoagulation.

Rutgeerts et al (15) studied Nd:YAG laser photocoagulation versus multipolar electrocoagulation for the treatment of severely bleeding ulcers. A randomized trial comparing the efficacy of BICAP electrocoagulation and Nd:YAG laser photocoagulation was carried out in 100 patients presenting at endoscopy with a spurting or oozing vessel, or a nonbleeding vessel. Fifty patients were enrolled in each treatment group. All lesions were pretreated with an injection of adrenaline 1:10,000. Subsequently, the lesions were treated with 1 to 2 s pulses of electrocoagulation of 25 watt BICAP at a setting of 10. The 10 F BICAP probe was always used. Definitive hemostasis after one treatment amounted to 32% in both the laser and in the BICAP group. After two sessions the cumulative success rate was 88% in the laser group and 80% in the BICAP group. Emergency surgery and mortality were also comparable. One perforation occurred in each treatment group and both patients were operated upon without complications. It was concluded that both Nd:YAG laser and BICAP were equally highly effective in the treatment of severe bleeding from peptic ulcers. This study stressed the importance of repeated treatment sessions in order to obtain optimal results.

From these data and others in the literature, it is concluded that the Nd:YAG laser and bipolar coagulation are equally effective for the treatment of solitary upper gastrointestinal bleeding lesions. Presently, an Nd:YAG laser unit costs 20 to 25 times more than a bipolar coagulator. The Nd:YAG is generally not portable so the patient must be transported to the laser unit, whereas the bipolar coagulator can be taken easily to the patient's bedside. Consequently, most authors now recommend that the bipolar coagulator be used in preference to the Nd:YAG laser. Since the heater probe may be more effective and cheaper than the Nd:YAG laser, it is also potentially preferable. Whether the heater probe is more efficacious than the bipolar coagulator remains to be determined.

THE HEATER PROBE

The heater probe is a device that can simultaneously give heat and pressure. It consists of a hollow aluminum cylinder with an inner heat coil and an outer coating of Teflon. The aluminum has high thermal conductivity which provides uniform distribution of the heat. Storey (16) reported on 15 patients with a gastric ulcer, mean age of 60 years and mean pretreatment blood transfusion requirement of 6.6 L, treated with the heater probe. All but one of the 15 patients avoided immediate operation and only two of the remaining patients had delayed bleeding, one of which required operation. There were no deaths in this group.

Over the same period there were 10 patients with duodenal ulcer with a mean age of 62 years and mean pretreatment blood transfusion requirement of 5 L. Operation was avoided in only two patients, of whom one had a small delayed hemorrhage which was treated conservatively. Of the rest, the technique failed in three because access was impossible owing to bleeding, contact was possible but unsuccessful in three patients and there were two patients with initial success followed by delayed hemorrhage necessitating operation. Three patients died during that admission. Perhaps this technique can well replace emergency operation in patients with bleeding gastric ulcers, but less commonly in those with duodenal ulcer.

Johnston and co-workers (17) compared heater probe and Nd:YAG laser in endoscopic treatment of major bleeding from peptic ulcers. The ultimate hemostatic success was achieved in 19 of 20 (95%) ulcers treated with the heater probe, compared with 24 of 35 (69%) YAG laser treated ulcers ($P<0.05$). The heater probe was employed with recent design changes, including Silverstone 'nonstick' coating over the probe tip. Also, a computer regulated maximal internal probe (3.2 mm in diameter) was used preferentially with the GIF–IT endoscope (although in two instances the small probe [2.4 mm] was used). Both probes included water irrigation. In cases of brisk ulcer bleeding, the inactivated heater probe was applied with moderate force, either directly or circumferentially around the bleeding site, to find a precise point that tamponaded bleeding. Upon successful vessel tamponade, water irrigation produced rapid clearing of blood from the ulcer base. At that juncture, several continuous heater probe pulses (each 30 J) were applied to thermally seal the compressed vessel. If bleeding recurred after initial hemostatic success, a second endoscopic heater probe treatment was performed immediately. This study indicated that heater probe treatments were more effective, easier and quicker than laser therapy.

Johnston et al (18) compared YAG laser, argon laser, monopolar and bipolar electrocoagulation, electrofulguration and heater probe in coagulation of canine arteries. They concluded that the most effective way to coagulate medium size mesenteric arteries was vessel occlusion by compression followed by heat application to seal it. Overall hemostatic ranking was heater probe, bipolar, monopolar, YAG, argon, electrofulguration. These data will be useful to clinicians planning endoscopic therapy of arterial bleeding. Future controlled clinical studies comparing heater probe, BICAP and YAG laser will be of interest.

The major disadvantage for monopolar electrocoagulation includes potential probe adherence to the tissue. The risk of perforation has been as high as 1.6% in some studies. The heater probe and BICAP were designed so that there is no potential for acute tissue erosion. No perforations have been reported to date with these instruments. Some disadvantages of the BICAP unit include suboptimal probe stiffness in design, lack of proximal water irrigation and a hemo-

static bond strength which is significantly less than the heater probe. The main disadvantage of the heater probe is long pulsation, during which time the probe must be kept in direct contact with the target.

SUMMARY

The field of endoscopic hemostatic therapy attracts much interest (19,20). There are certain limitations for endoscopic hemostatic therapy including inexperienced endoscopic therapists, severe concomitant medical disease that will increase mortality, lack of endoscopic access to the bleeding point, large unmovable clots and bleeding from the posterior wall of the cap which will reduce the effectiveness of therapeutic endoscopy.

Finally, there are few bleeding ulcers with an artery too large to expect endoscopic success. Presently, many important issues about therapeutic endoscopy remain unresolved and the kind of treatment chosen will be dictated by the availability of therapeutic modalities and the skill of the operator. No one type of treatment is best for all instances. It can be concluded that, for nonvariceal bleeding, injection therapy, electrocoagulation, laser photocoagulation and heater probe are reasonable considerations for endoscopic therapy.

REFERENCES

1. Goodale R, Okada A, Gonzales R, et al. Rapid endoscopic control of bleeding gastric erosions by laser radiation. Arch Surg 1970;101:211-4.
2. Kiefhaber P. International experience with lasers for gastrointestinal bleeding. Proceedings of the International Laser Congress. Detroit, 1972.
3. Swain C, Bown S, Salmon P, et al. Controlled trial of Nd:YAG laser photocoagulation in bleeding peptic ulcers. Lasers Surg Med 1983;3-11.
4. Macleod IA, Mills PR, Mackenzie JF, et al. Neodymium yttrium aluminum garnet laser photocoagulation for major haemorrhage from peptic ulcers and single vessels: A single blind controlled study. Br Med J 1983;286:345-8.
5. Halprin A, Anselm K. Nd:YAG laser in treatment of seriously ill patients with gastrointestinal bleeding. Gastrointest Endosc 1986;32:199-201.
6. Krejs GJ, Little KH, Westergaard H, et al. Laser photocoagulation for the treatment of acute peptic ulcer bleeding. N Engl J Med 1987;25:1618-21.
7. Vallon AG, Cotton PB, Laurence BN, et al. Randomized trial of argon laser photocoagulation in bleeding peptic ulcers. Gut 1981;22:228-33.
8. Swain CP, Storey DW, Northfield TC, et al. Controlled trial of argon laser photocoagulation in bleeding peptic ulcers. Lancet 1981;ii:1313-6.
9. Jensen DM, Machicado GA, Tapia JR, et al. Endoscopic argon laser photocoagulation of patients with severe gastrointestinal bleeding. Gastrointest Endosc 1982;28:151.
10. Waitman AM, Grand DZ, Chateau F. Argon laser photocoagulation treatment of patients with acute and chronic bleeding secondary to telangiectasia. Gastrointest Endosc 1982;28:153.
11. Bowers JM, Dixon J. Argon laser photocoagulation of vascular malformations in the GI tract. Gastrointest Endosc 1982;28:126.
12. Flesicher DE. Nd: YAG laser photocoagulation for UGI angiodysplasia. Gastrointest Endosc 1981;26:122.
13. Moreto M, Zabaila M, Ibanez S, et al. Efficacy of monopolar electrocoagulation in the treatment of bleeding gastric ulcer: A controlled trial. Endoscopy 1987;19:54-6.
14. Goff JS. Bipolar electrocoagulation versus Nd-YAG laser photocoagulation for upper gastrointestinal bleeding lesions. Dig Dis Sci 1986;31:906-10.
15. Rutgeerts P, Vantrappen G, Hootegem V, et al. Neodymium-YAG laser photocoagulation versus multipolar electrocoagulation for the treatment of severely bleeding ulcers: A randomized comparison. Gastrointest Endosc 1987;33:199-202.
16. Storey DW. Endoscopic control of peptic ulcer haemorrhage using the "heater probe". Gut 1983;24:967-8.
17. Johnston JH, Sones JQ, Long BW, et al. Comparison of heater probe and YAG laser in endoscopic treatment of major bleeding from peptic ulcers. Gastrointest Endosc 1985;31:175-80.
18. Johnston J, Jensen D, Jackson DA, et al. Comparison of endoscopic lasers, electrosurgery and the heater probe in coagulation of canine arteries. Gastrointest Endosc 1986;30:154.
19. Fleischer D. Endoscopic therapy of upper gastrointestinal bleeding in humans. Gastroenterology 1986;90:217-34.
20. Rutgeerts P, Van Gompel F, Geboes K, Vantrappen G, Broeckaert L, Coremans G. Long-term results of treatment of vascular malformations of the gastrointestinal tract by Neodymium Yag laser photocoagulation. Gut 1985;26:586-93.