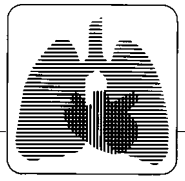

bronchoscopy

Nd-YAG Laser vs Bronchoscopic Electrocautery for Palliation of Symptomatic Airway Obstruction*

A Cost-Effectiveness Study

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Study objective: **To evaluate the cost effectiveness of the Nd-YAG laser and bronchoscopic electrocautery for palliation in patients with symptomatic tumor obstruction.**
Design: **A retrospective study.**
Setting: **Bronchoscopy unit of a university hospital.**
Patients and intervention: **Thirty-one consecutive patients with inoperable non-small cell lung cancer and symptomatic intraluminal tumor underwent bronchoscopic treatment. Dyspnea relief was the primary goal of treatment. Fourteen patients were treated with the Nd-YAG laser and 17 patients with electrocautery.**
Measurements and results: **Improvement of symptoms was achieved in 70% of patients treated by either Nd-YAG laser or electrocautery. Mean ± SD survival was 8.0 ± 2.5 months after Nd-YAG laser treatment and 11.5 ± 3.5 months after electrocautery. The number of treatment sessions per patient was comparable: Nd-YAG laser, 1.1; electrocautery, 1.2. Duration of hospital stay was longer in patients treated with the Nd-YAG laser (8.4 vs 6.7 days). Average treatment costs, including admission charges, were $5,321 for the Nd-YAG laser and $4,290 for electrocautery. Higher costs in the group treated with the Nd-YAG laser were caused by a longer hospital stay before bronchoscopic treatment. Costs of equipment (electrocautery $6,701 and Nd-YAG laser $208,333), write-offs, maintenance, and repair were not included in this calculation.**
Conclusion: **Bronchoscopic electrocautery is equally effective but is a less expensive and, in our hospital, a more accessible modality than the Nd-YAG laser for symptomatic palliation of patients with intraluminal airway obstruction.** ***(CHEST 1999; 116:1108–1112)***

Key words: bronchoscopic electrocautery; bronchoscopic treatment; cost effectiveness; Nd-YAG laser

Abbreviations: NSCLC = non-small cell lung cancer

Obstruction of the major airways with life-threatening dyspnea is frequently encountered in patients with inoperable non-small cell lung cancer (NSCLC).[1] Obstruction may be caused by an intraluminal tumor, extrinsic compression, or weakening of the bronchial wall. In cases with intraluminal tumor, various bronchoscopic techniques are available for tumor debulking. Mechanical tumor removal, lasers (*eg*, Nd-YAG, CO_2, argon), electrocautery, cryotherapy, photodynamic therapy, and brachytherapy are the alternatives. Any technique in experienced hands will be effective to obtain symptomatic relief.[2] Techniques that induce relatively late responses (brachytherapy) or cause secondary necrosis (*eg*, photodynamic therapy and cryotherapy) are less attractive in patients with imminent respiratory failure. Lasers (*eg*, Nd-YAG) and electrocautery, together with mechanical tumor removal, are more appropriate for this purpose.[2] The Nd-YAG laser is much more

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popular than electrocautery despite the high monetary investment, lower availability, and the lack of studies showing its superiority in terms of cost effectiveness. Recent studies have shown the competitive efficacy of electrocautery for tumor coagulation and debulking.[3–5] Although no randomized study has been performed, the efficacy of both techniques is comparable.[3–8] In a retrospective study, we investigated the cost effectiveness of both treatment facilities in our hospital in patients with symptomatic tracheobronchial obstruction due to NSCLC during two consecutive periods.

Materials and Methods

Patients included in this study had centrally located inoperable NSCLC and underwent bronchoscopic treatment between January 1994 and December 1996 because of dyspnea due to tracheobronchial obstruction caused by intraluminal tumor. Between January 1994 and March 1995, the laser (Nd-YAG; Sharplan Lasers, Allendale, NJ) was used; between March 1995 and December 1996, electrocautery was used. We had to use electrocautery (Valleylab; Boulder, CO) because of technical problems with our only Nd-YAG laser. Dyspnea relief was the immediate primary goal of treatment. The following parameters were retrospectively studied: previous treatment, site of airway obstruction, conditions under which the intervention took place, complications, number of treatment sessions, dyspnea improvement (evaluated as yes or no by Ton van Boxem and Maike Muller), additional treatment, other antitumor therapy, duration of hospital stay, time in hospital until intervention, the use of hospital facilities, duration of survival after bronchoscopic treatment, and total costs of intervention. Costs were studied up to 1 month after bronchoscopic intervention. These costs were calculated as the monetary amount of the claim submitted to the health insurance company. Equipment costs were not included in this calculation.

Techniques that were used for bronchoscopic electrocautery and the Nd-YAG laser were described before.[5,6] Both rigid and flexible bronchoscopes were used in most cases. Treatment was performed under local anesthesia in some subjects, while others received general anesthesia. Mechanical tumor removal and tumor coagulation were performed to obtain rapid airway clearance. Coagulation with either the Nd-YAG laser (noncontact mode) or electrocautery (probe-contact mode) was performed using power settings up to 55 W. Bronchoscopic electrocautery was performed using the rigid monopolar loop and suction probe or the fiberoptic bronchoscope with a flexible probe. The proper energy setting (± 30 W) was tested by touching an area of normal mucosa in the proximity of the tumor. The coagulative effect could be assessed immediately and energy setting adjusted as needed. The probe was then used to gently palpate the intraluminal tumor base along the tracheobronchial wall during coagulation. Tumor clearance after coagulation was performed by flushing, suctioning, and mechanical tumor removal. The treatment session was terminated when significant tumor clearance had been achieved.

Results

Thirty-one patients were included: 14 were treated with the Nd-YAG laser and 17 with electrocautery. Patient groups were comparable regarding age, sex, diagnosis, site of obstruction, time after intial diagnosis, and previous and current antitumor therapy (Table 1). General anesthesia was used more often in patients treated with the Nd-YAG laser. Improvement of symptoms was achieved in about 70% of patients in both treatment groups. No complications related to treatment technique were found in this study. Mean survival was 8.0 ± 2.5 months after Nd-YAG laser treatment and 11.5 ± 3.5 months after electrocautery. The number of treatment sessions was equal for both techniques. The duration of hospital stay, however, was longer in patients treated with the Nd-YAG laser (8.4 vs 6.7 days). This was related to a longer hospital stay before the bronchoscopic laser treatment. Average costs of treatment, including the admission charges per patient, were $5,324 for Nd-YAG laser treatment and $4,290 for electrocautery treatment. The costs of the equipment (electrocautery, $6,701; Nd-YAG laser, $208,333) were not included; nor were the costs of write-offs, maintenance, and repair. In Table 2, the treatment costs for the two bronchoscopic treatment groups are shown. Differences in costs were mainly attributed to the longer hospital stay in the group treated with the Nd-YAG laser.

Discussion

Duration of hospital stay was the most important factor determining costs of treatment in our hospital, expressed as the monetary amount of the claim submitted to the health insurance company. No differences in costs of services directly related to bronchoscopic treatment (*eg*, number of treatment sessions and bronchoscopic sessions) were found. The use of general anesthesia, which was more frequent in the group treated with the Nd-YAG laser, may have been a factor determining the longer hospital stay before bronchoscopic treatment in this group. However, patients who underwent electrocautery under general anesthesia also had a shorter hospital stay before bronchoscopic treatment than did the Nd-YAG laser group. Shorter hospital stay when electrocautery was used was probably related to the better logistics involved in performing electrocautery in our hospital. Less preparation and action is needed when electrocautery is used. Access to the Nd-YAG laser facility in our hospital is more complicated. Only one Nd-YAG laser machine is available, and it is shared by different specialists such as otolaryngology, gynecology, urology, surgery, and gastroenterology. Furthermore, the special facilities necessary for safe laser application are not available in every operating room. In contrast, electrocautery

Table 1—*Characteristics of the Patients Treated With Nd:YAG Laser or Electrocautery During Two Consecutive Study Periods

	Nd:YAG (n = 14)	Electrocautery (n = 17)
Sex		
Male	11	10
Female	3	7
Median age, yr	61 (range, 37–88)	62 (range, 47–79)
Diagnosis		
Adenocarcinoma	1	5
Squamous cell carcinoma	10	4
Large cell carcinoma	3	8
Disease stage		
IV	6	6
IIIB	6	10
IIIA	2	1
Previous therapy		
Surgery	3	1
Radiotherapy	6	4
Chemotherapy	4	4
Therapy after BT		
Radiotherapy	6	8
Chemotherapy	3	5
Time from diagnosis to BT, mo	4.7 ± 6 (range, 0–21)	7.5 ± 17 (range, 0–72)
Site of obstruction		
Trachea	3	3
RMB	4	9
LMB	5	3
BI	2	1
BI/LUL	—	1
General anesthesia	13 (95%)	6 (35%)
Improvement of symptoms	10 (71%)	13 (76%)
Sessions per patient	1.1 ± 0.3	1.2 ± 0.4
Complications	Hypotension (n = 1)	Hemoptysis/respiratory failure (n = 1)
Survival, mo	8.0 ± 2.5	11.5 ± 3.5

*Values are presented as No., mean ± SD, or No. (%) unless otherwise indicated. BT = bronchoscopic treatment; LMB = left main bronchus; RMB = right main bronchus; BI = bronchus intermedius; LUL = left upper lobe.

equipment is a standard instrument in almost every endoscopy and surgical unit, and no special facilities are required. We realize however, that specific hospital-related factors determined the costs of the two bronchoscopic treatment modalities in this study and that similar calculations in another hospital may reveal a different outcome. This also applies to the long hospital stay of the patients in this study. The reason for prolonged hospital admission was not always obvious in the patients' records in this retrospective study. In some cases, additional diagnostic tests and/or therapy (*eg*, chemotherapy, radiother-

Table 2—*Treatment Costs up to 1 Month After Bronchoscopic Treatment, Including Charges for Admission, Bronchoscopy, and General Anesthesia

	Nd:YAG Laser		Electrocautery	
Treatment Costs	No.	Costs, $	No.	Costs, $
Total costs per patient		5,324		4,290
BT sessions	1.1 ± 0.3	402	1.2 ± 0.4	441
Extra sessions	1.7 ± 0.8	425	1.5 ± 0.6	375
Hospital stay, d	3.3 ± 2.5	1,650	1.7 ± 1.6	850
Before BT				
Hospital stay, d	8.4 ± 4.0	4,200	6.7 ± 5.3	3,350
General anesthesia, %	93	232	35	87
Additional costs		65		37
Equipment costs		208,000		6,701

*Values under No. are mean ± SD unless otherwise indicated. See Table 1 for abbreviations.

apy) were carried out, and in others, general conditions and specific health problems were reasons for prolonged admission. Therefore, we made a distinction between hospital stays before and after the bronchoscopic intervention. Hospital stay after bronchoscopic intervention was comparable between the two groups, and all patients were primarily admitted for the bronchoscopic intervention. The retrospective character of this study makes it impossible to trace the exact duration of hospital stay strictly associated with the bronchoscopic intervention. Nevertheless, regardless of these treatment-related costs, Nd-YAG laser equipment is more expensive than electrocautery equipment, and other costs associated with lasers (maintenance, repair, and write-offs) are much higher. In our hospital, our department and others carry out 100 Nd-YAG laser sessions per year. Assuming a write-off duration of 10 years and estimated maintenance and repair costs of $1,000 per year, costs per session are $218. The same calculation for electrocautery equipment yields an estimated cost per session of $10.

The efficacy of the Nd-YAG laser in the tracheobronchial tree has been reported before.[6–8] This study confirmed our experience that, compared with the Nd-YAG laser, electrocautery seems equally effective for debulking intraluminal tumors. During an earlier study, we noticed a similar effectiveness for electrocautery performed under local anesthesia using a fiberoptic bronchoscope in patients with central airway malignancies.[4] A randomized trial is necessary to give a definite answer. Results could be biased by patient selection and the choice of technique. However, in this study, the decision to use electrocautery was based on the fact that the Nd-YAG laser equipment was malfunctioning and electrocautery was the only alternative. Although the duration of each treatment session could not be traced in most cases in this retrospective study, in our experience, the time needed to achieve tumor clearance is comparable. We believe that electrocautery, together with mechanical tumor removal, is a straightforward, safe, and quick method to restore airway patency.[4] The electrocautery probe also allows safe palpation of the tumor and the tracheobronchial wall. The use of a flexible probe improves its maneuverability.[4,5] The rigid system offers optimal airway management and allows fast removal of substantial amounts of tumor. Compared with the Nd-YAG laser, electrocautery is, in our opinion, better suited to the daily clinical practice of every bronchoscopist, using either the fiberoptic bronchoscope or the rigid scope. Electrocautery is commonly applied in surgery and gastroenterology but has received little attention for tracheobronchial use.[9] Reasons for its incidental use in endobronchial treatment remain obscure. Krell and Prakash[10] mentioned repetitive cleaning because of carbonized tissue covering the probe as a disadvantage and as the reason that it is a time-consuming procedure. In our experience, the cleaning of the probe is not time-consuming. The bronchoscopy assistant cleans the probe each time it is withdrawn, while the bronchoscopist performs mechanical tumor removal after sufficient coagulation. Mechanical tumor removal after coagulation often allows quick clearance of substantial amounts of tumor. A tracheal fire while using bronchoscopic electrocautery was reported by Hooper and Jackson[11] and may have contributed to the unpopularity of electrocautery. This rare complication may occur during Nd-YAG laser treatment as well.[12] The fire hazard exists only when flammable material and oxygen are both present near the cautery probe or laser beam, which produce extreme heat. Another point of argument is the greater depth effect of the Nd-YAG laser. Although this is mainly mentioned as an advantage of the technique, it is also a potential danger when the Nd-YAG laser is used in less experienced hands lacking the expertise and knowledge of the laser-tissue interaction: hence the importance of the safety guidelines in using the Nd-YAG laser.[6] Clinicians must keep in mind the anatomy of the tracheobronchial tree and the surrounding vascular stuctures, especially in patients with cancer recurrence after prior surgery or radiation therapy.

In conclusion, electrocautery seems more cost-effective than the Nd-YAG laser for palliative bronchoscopic intervention to debulk intraluminal tumor in patients with NSCLC. Electrocautery equipment is less expensive, the application technique is simple, and it is more easily accessible for emergency use in most hospitals. In this study, treatment with bronchoscopic electrocautery was less costly than Nd-YAG laser treatment. The main contributing factor was shorter hospital stays before bronchoscopic treatment using electrocautery, probably related to better logistics for electrocautery in our hospital.

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