

# The Use of Electrocautery as the Primary Ablation Modality for Malignant and Benign Airway Obstruction

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**Background:** Laser has been the main ablative modality in the airways, but a growing experience with endobronchial electrocautery suggests a comparable efficacy and safety profile.

**Objectives:** To evaluate the efficacy and safety of electrocautery as the primary heat therapy for malignant and benign airway obstruction.

**Methods:** A retrospective review of all patients undergoing endobronchial electrocautery, alone or in combination with other airway tools, at Duke University Medical Center between April 2004 and November 2009. Data on efficacy (luminal patency, symptomatic, radiographic, or physiologic improvement) and safety (complication rate) were collected.

**Results:** Ninety-four patients underwent 117 procedures with endobronchial electrocautery for endobronchial malignant and nonmalignant disease. Endoscopic improvement was seen in 94% of cases. Seventy-one percent of patients reported symptomatic improvement. Radiographic studies demonstrated luminal improvement in 78% of patients on chest computed tomography, improved aeration on chest computed tomography and chest x-ray in 63% and 43% of patients, respectively. The rate of major complications was 0.8%, whereas minor complications occurred in 6.8% of cases. There was no perioperative mortality.

**Conclusions:** Endobronchial electrocautery is effective and safe when used as an ablative modality in malignant and benign airway obstruction and has a comparable profile to laser with the advantage of lower cost.

**Key Words:** Bronchoscopy, Interventional pulmonology, Electrocautery, Airway obstruction, Lung cancer.

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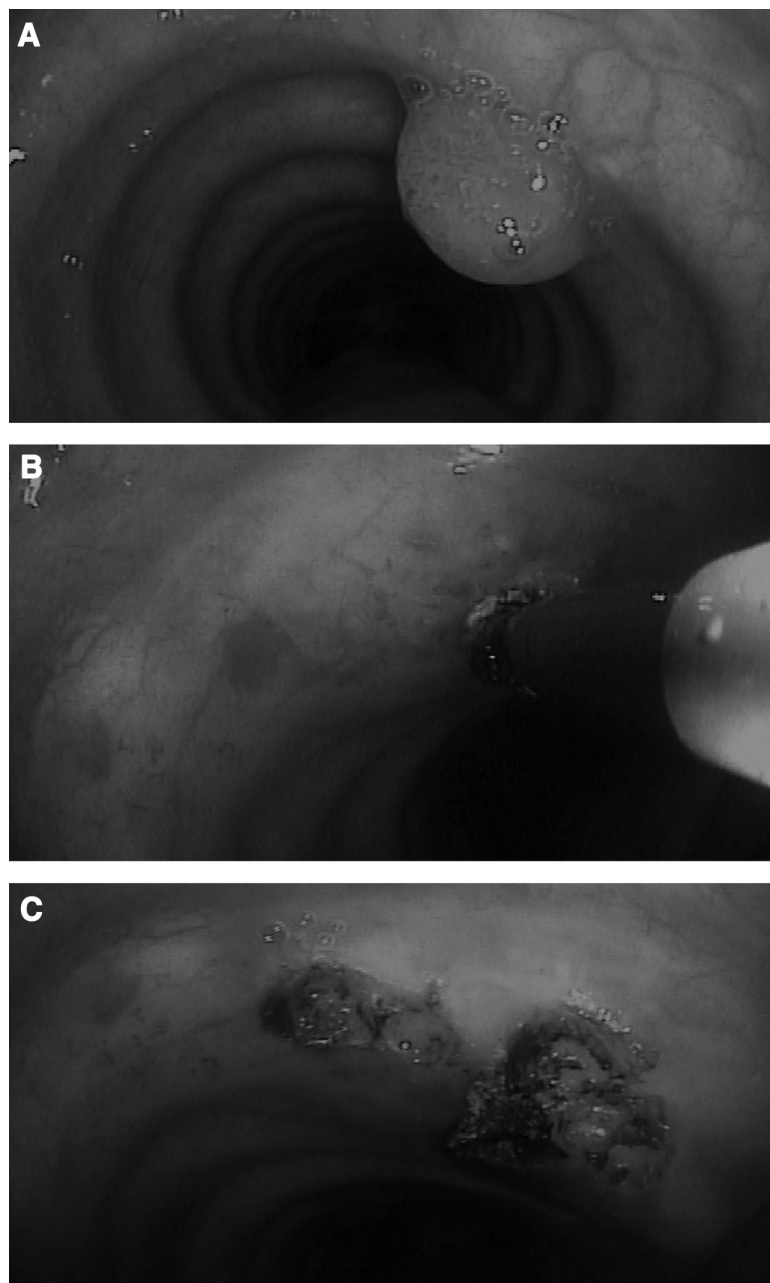
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The use of therapeutic bronchoscopy has increased over the past two decades.<sup>1–3</sup> Therapeutic bronchoscopic interventions aim at the treatment of both malignant and nonmalignant causes of central airway obstruction and include a wide spectrum of modalities including mechanical debridement, airway dilatation, ablative therapies, and airway stenting. Each modality is used alone or in combination with other tools to achieve the desired effect. Currently available ablative therapies include those with immediate effect: Nd:yttrium aluminum garnet (YAG) laser, electrocautery, argon plasma coagulation (APC); and those with delayed effect: cryotherapy, photodynamic therapy, and brachytherapy.<sup>1,2,4</sup> Laser, electrocautery, and APC can be used to directly vaporize tissue or, more commonly, to coagulate tissue before mechanical debridement.<sup>1,3,5</sup> APC is used effectively in superficial lesions, but the tissue penetration is limited to only 1 to 2 mm.<sup>2,6</sup> Laser can attain tissue penetration of up to 10 mm and can be used when deeper tissue penetration is needed.<sup>2,6</sup> Multiple studies have demonstrated the efficacy of laser in the treatment of central airway obstruction in terms of symptomatic and radiographic improvement with a low complication rate in experienced hands.<sup>2,7–12</sup> Because of the aforementioned favorable profile, laser became the main airway ablative modality in the nineties; however, its wide adoption in clinical practice was fraught with its high cost, bulky size of machine, and the need for protective eyewear.<sup>1</sup>

Electrocautery is an alternative heat ablative therapy in the airway that uses an electrical current to generate heat and cause tissue destruction. Its advantages over laser are its lower cost, ease of use, and wide availability in most hospitals. Common devices used with electrocautery include the snare, knife, blunt probe, and hot forceps. The snare is used to lasso a lesion at its base, which is useful in pedunculated airway lesions. Electrocautery knife is used to cut through tissue and is especially effective in disrupting benign stenotic webs. The blunt probe is used in direct contact with the lesion and cause tissue coagulation and destruction. Hot forceps deliver heat while a biopsy is taken and can be used for transbronchial or endobronchial biopsy; however, their effectiveness have come into question, and they are not commonly used.<sup>13,14</sup> Figure 1 shows an electrocautery application through the probe on an endotracheal lesion.

Endobronchial electrocautery has not been studied extensively, but small series have demonstrated that, similar to



**FIGURE 1.** An electrocautery application through the probe on an endotracheal lesion: (A) endotracheal polypoid lesion; (B) electrocautery application through the probe; and (C) site of tracheal lesion after electrocautery application.

laser, it can achieve high success rates for the relief of central airway obstruction with favorable safety profile.<sup>15–20</sup>

In our institution, we use electrocautery rather than laser as the first-line heat therapy for central airway obstruction. In this study, we will review our experience with electrocautery with focus on its efficacy and safety.

## METHODS

### Study Design and Patients

We retrospectively reviewed all patients referred to Duke University Medical Center for central airway obstruction between April 2004 and November 2009 and selected

those who underwent endobronchial electrocautery. This retrospective analysis was approved by the Duke University Institutional Review Board. All procedures were performed under the direction of the Duke University Interventional Pulmonary Group.

Electrocautery was performed using a device manufactured by ERBE surgical systems (Atlanta, GA). Electrocautery accessories used included the electrocautery snare, knife, and monopolar probes (Olympus, Center Valley, PA). Standardized protocols for appropriate power selection were used in accordance with the manufacturer recommendations. Escalating wattage was used as indicated to achieve the desired effect.

## Data Collection and Measurements

Pre- and postoperative data, including procedure notes, clinic visits, pulmonary function tests, and radiographic images were accessed using the institution's electronic medical record and radiology systems. Information was entered into a password-protected database that was accessed by study personnel only.

The primary outcomes of the study were patients' response to treatment and rate of complications. Response to the treatment was determined by four factors. Endoscopic luminal improvement was evaluated as improved or not improved according to the bronchoscopy procedure note; an improvement was deemed to occur if there was at least 50% improvement in the bronchial lumen. Patient symptoms were evaluated in postprocedure clinic notes as improved, worsened, or unchanged. Radiographic data were reviewed when both pre- and postprocedure studies were available. Radiographic data were evaluated for improvement in the airway lumen and improvement in aeration of the targeted lung fields. Spirometry data were reviewed when pre- and postprocedure studies were available. Improvement was considered to be present if there was greater than 10% improvement in postprocedure data. Any perioperative or postoperative complications were recorded.

## RESULTS

Ninety-four patients underwent 117 procedures with endobronchial electrocautery for airway obstruction. Patients and diseases characteristics are summarized in Table 1. The majority of patients had malignancy as the primary indication for intervention, most frequently a lung cancer primary. The site of intervention most often involved the trachea or mainstem bronchi. Presenting symptoms included shortness of breath (68%), cough (34%), hemoptysis (15%), wheezing (11%), and constitutional symptoms (10%).

Rigid bronchoscopy was performed in 62% of the procedures, whereas the rest were performed with flexible bronchoscopy. The electrocautery probe was used in 78% of procedures, knife in 15%, and snare in 7%. The average energy used with electrocautery was 30 Watts, but it is worth noting that the energy used with electrocautery can vary significantly based on the manufacturer of the energy source and accessories. Endobronchial electrocautery was typically accompanied by additional modalities including balloon dilation in 25%, tissue excisions in 60%, and airway stenting in 31% of procedures. Stents used during the procedures were silicone in 47%, metallic in 35%, and hybrid in 18% of cases.

Table 2 summarizes patients' outcomes. Endoscopic improvement was seen in 94% of patients undergoing endobronchial electrocautery. Postoperatively, 71% of patients reported symptomatic improvement, 13% noted worsening, and 16% had no change. One month after the procedure, 6% of the patients had deceased.

Radiographic data were reviewed when available pre- and postprocedure. Twenty-three patients had chest computed tomography available for comparison, with 78% demonstrating luminal improvement. Furthermore, 63% of patients with complete or partial lung collapse demon-

**TABLE 1.** Baseline Characteristics

Characteristics	Values
Age (yr)	
Mean	56
Range	18–83
Male	71 (61)
Race and ethnicity	
White	87 (75)
African American	26 (22)
Asian	4 (3)
Disease type	
Lung cancer	52 (44)
Extrathoracic cancer	30 (26)
Lung transplant	10 (9)
Nonmalignant disease	25 (21)
Tracheal stenosis	8 (32)
Amyloidosis	6 (24)
Granulation tissue	4 (16)
Papillomatosis	2 (8)
Benign tumor	2 (8)
Foreign body	1 (4)
Other	2 (8)
Location of lesion <sup>a</sup>	
Trachea	24 (15)
Mainstem bronchi	60 (38)
Bronchus intermedius	26 (16)
Lobar and higher order bronchi	22 (14)
Lobar bronchi only	27 (17)

*n* = 117 unless noted. Results as number (%).

<sup>a</sup> *n* = 159, as several patients underwent electrocautery at multiple sites.

**TABLE 2.** Electrocautery Patient Outcomes

Outcomes	Value
Endoscopic improvement	110 (94)
Major complication <sup>a</sup>	1 (0.8)
Minor complications	8 (7)
Patient symptoms <sup>b</sup>	
Improvement	66 (71)
Worsening	12 (13)
No change	15 (16)
Radiologic data	
Improvement on chest CT <sup>c</sup>	18 (78)
Improvement on chest x-ray <sup>d</sup>	9 (43)
Spirometry <sup>e</sup>	
Improvement in FEV1 > 10%	5 (36)

Results as number (%). *n* = 117 unless noted.

<sup>a</sup> Patient aspirated during anesthesia induction and went into atrial fibrillation.

<sup>b</sup> *n* = 93.

<sup>c</sup> *n* = 23.

<sup>d</sup> *n* = 21.

<sup>e</sup> *n* = 14.

FEV<sub>1</sub>, forced expiratory volume in 1 second; CT, computed tomography.

strated improved aeration on postprocedure chest computed tomography. Among patients who only had pre- and postprocedure chest x-rays, 43% of patients with complete or partial lung collapse demonstrated improvement, al-

though a majority of the postoperative films were portable, making sensitivity poor.

Fourteen patients had spirometry performed both pre and postoperatively. Improvement in the forced expiratory volume in 1 second or forced vital capacity of at least 10% was found in 36% of cases, whereas 50% showed no improvement, and worsening occurred in 14%.

There was only one major complication (0.8%). This occurred when a patient aspirated during anesthesia induction and subsequently went into atrial fibrillation with rapid ventricular response. There were eight minor complications (6.8%) including minor bleeding (3), postprocedure bronchospasm (2), pneumonia (2), and a chipped tooth (1).

## DISCUSSION

Despite the use of endobronchial electrocautery over the past 25 years for the treatment of central airway obstruction due to malignant and nonmalignant causes, a relative paucity of data exists to verify its safety and efficacy, with much of the data in the form of small case series.

The utilization of endobronchial electrocautery was first described in 1932 but was used infrequently over the next half century due to safety concerns.<sup>21</sup> There was initial difficulties with grounding, placing the bronchoscopist at potential risk for electric shock; however, newer systems overcame this problem by offering grounded bronchoscopes and bipolar probes that do not require grounding.<sup>1,2,4,18</sup> In 1985, Hooper and Jackson<sup>16</sup> described a series of four endobronchial electrocautery cases. Three of these cases were successful in relieving major airway obstruction, and the fourth was successful in obtaining a diagnosis. They followed this up with a more extensive series in 1988 of 18 patients, 13 with malignant disease and five with nonmalignant airways disease.<sup>17</sup> The majority of these patients were treated with electrocautery snare. They reported good success with the snare and no complications. An additional case series documenting 17 patients with central airway obstruction from lung cancer treated with electrocautery was published in 1994.<sup>19</sup> Fifteen of these patients had immediate airway improvement, 11 had improvement of the lumen size to 75% of normal, and eight reported improvement in dyspnea. The safety of endobronchial electrocautery was further evaluated in a prospective study of 37 patients, which found no major complications and no mortality.<sup>18</sup> In addition to its use in central airway obstruction, van Boxem et al.<sup>20</sup> demonstrated the role of electrocautery as a curative measure for radiographic occult lung cancer.

Our study represents the largest collection published to date of patients who have undergone endobronchial electrocautery as the primary ablative therapy for central airway obstruction. This retrospective study reinforces a very favorable efficacy and safety profile with luminal improvement achieved in 94% of the cases and symptomatic improvement in 71% of patients. There were few minor and major complications in this series, and the majority of them can be attributed to bronchoscopy and anesthesia rather than endobronchial electrocautery per se.

This profile compares favorably to laser therapy. Multiple past studies have demonstrated the efficacy of laser in the treatment of central airway obstruction.<sup>8,11,22</sup> Improvement in symptoms relief has been demonstrated in 63 to 94% of patients who underwent laser therapy as part of a multimodality approach for central airway obstruction, whereas improvement in lumen has been shown in 83 to 93% of patients.<sup>8,11,22</sup> In the largest series describing the use of laser in malignant airway obstruction, which included 2610 procedures in 1838 patients, there were a total of 60 complications associated with the use of laser, leading to 12 deaths.<sup>9</sup> The most common complications included hemorrhage and respiratory failure.

One perceived advantage of electrocautery over laser therapy is the cost, as both the initial investment in an endobronchial electrocautery system and the maintenance are a fraction of the cost of a laser system. Boxem et al.<sup>7</sup> published a prospective study attempting to evaluate the cost-effectiveness of laser versus electrocautery. They found similar efficacy but higher costs for the laser group. Nevertheless, they were unable to capture the equipment cost, and the difference was entirely due to the variance in the length of hospital stay before the procedure. Coulter and Mehta<sup>15</sup> presented a prospective case series of 118 patients with endobronchial obstruction that were evaluated for endobronchial electrocautery. Forty percent of these patients were felt to have lesions amenable to intervention with endobronchial electrocautery; the remainder underwent intervention with laser. Eighty-nine percent of the electrocautery interventions were successful, alleviating the need for Nd:YAG laser therapy and presumably reducing costs.

There are likely several reasons for the significant growth in the use of laser with only minimal interest in electrocautery. First, the safety profile of endobronchial electrocautery with some of the earlier equipment for both the patient and the clinician was questionable.<sup>2,16</sup> Advances in endobronchial electrocautery technology, however, have alleviated the previous concerns with safety. Second, there is a belief that endobronchial electrocautery is not suitable for the treatment of large central airway masses due to its potential lower depth of effect as compared with laser. Although, in some situations with larger lesions, electrocautery may take longer to complete the procedure, we believe that the outcomes are equal to that of laser. Third, a concern exists surrounding the fact that electrocautery is a contact modality, when compared with the noncontact laser and contact may theoretically induce more bleeding. This concern has not been verified in studies on endobronchial electrocautery with no reported increased incidence of bleeding.

Our study has several limitations including the retrospective design that may affect the quality of collected data, the use of additional modalities in the airways beside electrocautery, the lack of a standardized scale to assess patient symptoms pre- and postprocedure, and the small number of radiographic and spirometry data pre- and postprocedure. Nevertheless, our study represents the largest series on endobronchial electrocautery and continues to build the case for using it as a major airway ablative modality.



## CONCLUSIONS

Laser and electrocautery represent the major thermal modalities to treat malignant and nonmalignant causes of significant central airway obstruction. Laser has been more widely used over the past two decades, although there are no data that suggests its superiority in efficacy or safety. A small body of literature suggests that endobronchial electrocautery is equally effective and safe as laser with significantly lower equipment cost. Our study will hopefully add to this literature and solidify endobronchial electrocautery's role in therapeutic bronchoscopy. A well-designed, prospective trial comparing laser and electrocautery is needed to further delineate the appropriate role of each modality in the treatment of central airway obstruction.

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