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Role of Electrocautery in Central Airway Obstruction

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Abstract

To evaluate the safety, efficacy and the post-procedural symptomatic improvement of patients with CAO undergoing Electrocautery as a bronchoscopic ablation technique. This study was done in Chest department, Kasr Al Ainy hospital, Cairo University; we enrolled Seventeen patients diagnosed with central airway obstruction (CAO), all patients were subjected to medical history and clinical examination, blood tests (CBC, KFT, LFT, coagulation profile, and ABG), and Radiology (CXR and CT chest). All Patients underwent Electrocautery ablation technique via bronchoscopy. In our study population, we had 14 males and 11 smokers with an average age 46.5±7.00 years old. Electrocautery showed significant improvement in the relief of symptoms (Cough, Dyspnea) post-procedural and a favorable outcome with a low complication rate. The duration of the procedure was 44.3 ± 24.1 min. Electrocautery can be used in the management of central airway obstruction to improve symptoms and to achieve recanalization with minimal complications according to our study.

Keywords: Endobronchial neoplasms, electrocautery, Lung cancer, ablation, central airway obstruction.

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1. Introduction

Central airway obstruction (CAO) is mostly seen in malignant obstructive lung diseases but can be found in benign conditions as well. An endoscopic intervention may be needed to ensure the patency of the airways. This may be either a palliative method to alleviate symptoms or a more definitive therapeutic approach [1]. Since CAO has multiple etiologies and different expressions, a clear definition and classification is of utmost relevance, as to estimate prognosis and determine the best therapeutic options [2]. Compromise of the central airways may produce clinical symptoms of dyspnea, wheezes, stridor and obstructive pneumonia. This can be a life-threatening situation with impending suffocation. The efficacy of bronchoscopic ablation techniques for palliation of patients with central airways obstruction has been established and its curative potential for intralesional treatment of early cancer has raised great interest in current screening programs [3]. Electrocautery is considered one of the recognized bronchoscopic ablation techniques using an electrical probe or snare to deliver a monopolar electrical current for heating the tissue in contact with the instrument. Electrical current is conducted by the insulated metal wire probe toward the target tissue. Due to the voltage difference between the probe and tissue, heat is generated at the point of contact by the electron current density, resulting in vaporization, coagulation or fulguration [4]. There is a risk of perforation with electrocautery, potentially leading to pneumothorax and pneumomediastinum especially when the contact is adjacent to the airway wall. Bleeding occurrence varies depending on the site and vascularity of the lesion but it usually stops due to the effect of thermocoagulation. The use of electricity in the airway has the inherent risk of airway fire, shock and electrical burns if the appropriate precautions are not undertaken [5]. We conducted a cross-sectional study for patients with CAO undergoing Electrocautery as an ablation method to compare their symptomatic improvement, complications and recanalization rate.

2. Methods

This is a cross-sectional study and we enrolled Seventeen patients with symptoms of CAO (e.g; dyspnoea, stridor, obstructive pneumonia) of benign origin or malignant inoperable central airway obstruction due to anatomical limitations or medical comorbidities in the Chest department, Kasr Al Ainy hospital, Cairo University in the period from June 2020 to December 2022.

Any adult patient with CAO and fit for bronchoscopic ablation by Electrocautery was eligible for inclusion in our study. Patients who reported coagulopathy (INR>1.5), Severe refractory hypoxemia, Hypoventilation with hypercapnia (type 2 respiratory failure), Severe pulmonary hypertension >55 mmHg by echocardiography, or hemodynamic instability were excluded from the current study. All patients were subjected to detailed history taking, history of present illness, thorough physical examination, evaluation of dyspnea according to the New York Heart Association (NYHA), evaluation of cough, evaluation of hemoptysis, laboratory investigations including complete blood picture, liver and kidney function tests, coagulation profile, fasting blood glucose, and Arterial blood gases. All patients underwent plain Chest X-ray (PA view) and CT chest imaging.

2.1. Fiberoptic Bronchoscopic Procedures

Bronchoscope with a flexible tip: Pentax EB-1970 TK electrocautery was performed using a 3.2mm working channel. The patients were required to fast for 6 to 8 hours before undergoing fiberoptic bronchoscopy. Premedication was administered in the form of intramuscular atropine (0.5 mg). Atropine's anti-cholinergic effects may lower airway secretions and the likelihood of reflex vasovagal symptoms such bronchoconstriction and bradycardia. The Freitag scheme was used to determine the location and degree of obstruction [6].

2.2. Technique of Bronchoscopy

The bronchoscope shaft is placed into an endotracheal tube size 8 after being thoroughly lubricated with 2% lidocaine gel following general anesthesia and intubation.

2.3. Electrocautery technique

After bronchoscopic confirmation of the airway obstruction, flexible electrocautery snare (Figure 1) or forceps (Figure 2) were used for coagulation. A monopolar system was used in this study. With monopolar systems, the electron flow was focused towards the area of contact between the probe and tissue. Monopolar systems require the electrocautery generator (Figure 3), bronchoscope, and patient to be grounded to complete the electrical circuit. If proper grounding is not performed, shocks and burns can occur. The patient was grounded with an electrode pad placed on the extremity nearer to the site of electrocauterization. During the use of monopolar systems, an insulated bronchoscope was used to reduce the risk of shock and burn to the bronchoscopist [7]. Once the tissue is coagulated, it is removed with mechanical debridement. If the contact time is prolonged, desiccation, carbonization, and vaporization of the tissue can occur. The electrocautery snare (Figure 1) is typically used for polypoid lesions. It is looped around the base or stalk of the polyp and retracted while activating the electrocautery for cut and coagulation. As the polyp is cut, hemostasis is achieved with coagulation and charring of the stalk. A major benefit of the snare is that it can preserve tissue for pathologic evaluation. The electrocautery knife is commonly used for making radial incisions in nonmalignant airway stenosis, as an adjunct to dilation. Electrocautery forceps can be used for both endobronchial and transbronchial biopsies and coagulation at the same time to decrease bleeding, but their efficacy in hemostasis is not proven [8].

2.4. The setting of the electrocautery apparatus used

- Monopolar mode.
- Soft coagulation technique.
- Depth: starting with 2 and increasing gradually till 4.
- Voltage started at 30w and increased gradually till 60w according to thicknesses of mass.
- The duration of the session was approximately from 20 to 60 min according to the response to therapy mass size, the opening of airways, and patient tolerability.

Coagulated or vaporized tissues were removed mechanically by forceps or with suction. In the cases of bulky tumors, electrocautery was used to coagulate the tumor base to shut off vascular structures and to reduce the risk of bleeding when tumor tissue was mechanically removed [8].

2.5. After bronchoscopy

Within 2 h after the procedure, a chest X-ray was done to exclude pneumothorax. Any complications observed were recorded, particularly bleeding and pneumothorax. Also, the patients were evaluated after 1 month for clinical symptomatic improvement.

2.6. Ethical considerations

Study protocol, and written informed consent were submitted for approval from the local ethical committee of Cairo university, and approval was granted with code: (MD-176-2020). All patients were informed about the full details of the procedure and informed consent was obtained. The data was analyzed by SPSS (statistical package for social science) version 26.0 on IBM compatible computer (SPSS Inc., Chicago, IL, USA).

2.7. Descriptive statistics

Descriptive statistics in which quantitative data will be presented in the form of mean, standard deviation (SD), median and range and qualitative data will be presented in the form numbers (n) and percentages (%).

2.8. Analytic statistics

Tests of significance which were used:

- **Paired t-test:** was used for comparison of quantitative variables before and after the procedure.
- **Marginal homogeneity test:** was used for comparison of qualitative variables before and after the procedure.

Results were considered statistically significant at a P value of less than 0.05.

3. Results and Discussion

This cross-sectional study enrolled 17 patients with CAO undergoing electrocautery, where the mean age was 46.5±7.00 and predominantly males (14 patients, 82.3%) and smokers (11 patients, 64.7%).

Symptomatic improvement was statistically significant peri-procedural in cough and dyspnea score ($p < 0.05$) observed in Table 1. According to Table 2, the location of the lesion in this group was found predominantly in the trachea (n=9, 52.9%) followed by the main bronchus (n=5, 29.4%) then a dual location meaning is extending from the main bronchus towards the trachea (n=3 16.7%). Malignant lesions (70.6%) were more common than benign ones, with squamous cell carcinoma as the most common of sub-types (33%). The degree of obstruction observed in these patients, according to Freitag et al., (2007) classification (Figure 4), was most commonly complete (n=7, 42%) followed by 90% (n=5, 29.4%) then 75% (n=3, 17.6%) and 50 (n=2, 11.8%). The mean duration of the procedure was 44.3± 24.1 min. Fourteen patients underwent one session and only 3 patients had 2 sessions (Table 3). The success rate of complete canalization was 70.6% with only 2 complications observed in our study; 1 perforation and 1 respiratory failure (11%). Central airway obstruction (CAO) may manifest as a life-threatening condition and can significantly impact the patient's quality of life (QoL). Unfortunately, this condition remains underdiagnosed [9]. Although surgical treatment remains the gold standard, the emergence of bronchoscopic ablation techniques has paved the way for a less-invasive, safer modality [10]. Bronchoscopic electrocautery, one of the well-established ablation techniques, is most commonly indicated in inoperable symptomatic malignant airway obstructions or as a combined-method other treatment modalities [11-12]. We included Seventeen patients with CAO, in our cross-sectional study, who underwent bronchoscopic electrocautery. The underlying etiology was either of benign origin (n=5) and malignant airway obstruction either due to an inoperable state (n=12). In another study, Sutedja G. et al., (1994) applied electrocautery in cases with bronchogenic carcinomas, endobronchial metastases, bronchial carcinoids [13]. According to the location of the lesion found radiologically, the most common site in our study was the trachea (n=9, 52%) followed by the main bronchus (n=5, 29%) then a dual level of both sites (n=3, 16.7%). The most common subtype of malignant obstruction was squamous cell carcinoma, while for the benign subtypes was foreign body (F.B)-induced granuloma. According to Freitag et al. classification, we had 7 cases with complete airway obstruction, 5 cases with "90%", 3 cases with "75%" and 2 cases with "50%". Wahidi MM et al., (2011) succeeded in restoring the airway patency in 80% of patients which were similar to our study with 70.6% success rate with complete canalization [14]. We encountered 2 complications in our study (11.6%); type II respiratory failure and perforation. A multi-center study by Ost DE et al., (2015) showed significant variation between centers in complication rates (range, 0.9%-11.7%) [15]. The symptoms assessment before and after the procedure showed significant improvement in cough and dyspnea. The dyspnea score was also significantly lower after the procedure than before the procedure. This was concordant with Ost DE et al., (2015) who found a lower dyspnea score post-procedural using Borg scale [16]. The patients underwent one (82.4%) or two (17.6%) sessions of electrocautery based on the bronchoscopist's judgement and the patient's tolerance to achieve the best possible outcome. The mean duration of the procedure was 44.3 ± 24.1 min.

Table 1: Comparison between symptoms pre and post procedural regarding Electrocautery.

Electrocautery (n=17)		Pre	Post	P value
Cough	No Cough does not disturb sleep. Cough disturbs sleep.	0 4 (23.5%) 13 (76.5%)	3 (17.6%) 10 (58.8%) 4 (23.5%)	0.05@
Dyspnea	No Class I Class II Class III Class IV	0 1 (5.9%) 1 (5.9%) 9 (52.9%) 6 (35.3%)	3 (17.6%) 6 (35.3%) 5 (29.4%) 3 (17.6%) 0	0.01@
Hemoptysis	No Streaks of blood in sputum. Clots of blood in 4 days or <2w. Clots in 5 or more days. Blood transfusion.	8 (47.1%) 3 (17.6%) 2 (11.8%) 2 (11.8%) 2 (11.8%)	13 (76.5%) 3 (17.6%) 1 (5.9%)	0.3@
Chest pain	No Yes	16 (94.1%) 1 (5.9%)	16 (94.1%) 1 (5.9%)	
Dyspnea Score (NYHA)	Mean ± SD	3.12 ± 0.93	1.47 ± 1.01	<0.01

$ two sample t-test. @ Marginal homogeneity test.

Table 2: airway obstruction-related characteristics and procedural specifications among the studied group (N=17).

Variable		Electrocautery
Location of the Lesion Radiologically (CT Chest)	Trachea Main bronchus Combined	9 (52.9%) 5 (29.4%) 3 (16.7%)
Cause of airway obstruction	Benign Malignant	5 (29.4%) 12 (70.6%)
Subtypes of benign obstruction	FB induced granuloma. Post-intubation stenosis. Mucous gland adenoma.	3 (60%) 1 (20%) 1 (20%)
Subtypes of malignant obstruction	Carcinoid tumor. Squamous cell carcinoma. Adenocarcinoma. Adenoid cyst carcinoma. Hodgkin's lymphoma Myofibroblastic tumor	3 (25%) 4 (33.3%) 1 (8.3%) 2 (16.7%) 1 (8.3%) 1 (8.3%)
Degree of airway obstruction	25% 50% 75% 90% Complete	0 2 (11.8%) 3 (17.6%) 5 (29.4%) 7 (41.2%)
Number of sessions	1 2	14 (82.4%) 3 (17.6%)
Duration of the procedure (min)	Mean ± SD	44.3 ± 24.1

Table 3: Type of outcome and complications related to the procedure.

Variable		Electrocautery (n=17)
Type of outcome	Complete canalization Partial canalization Failure	12 (70.6%) 5 (29.4%) 0
Complications	Yes No	2 (11.8%) 15 (88.2%)
Type of complications	Respiratory failure 2 Perforation	1 1

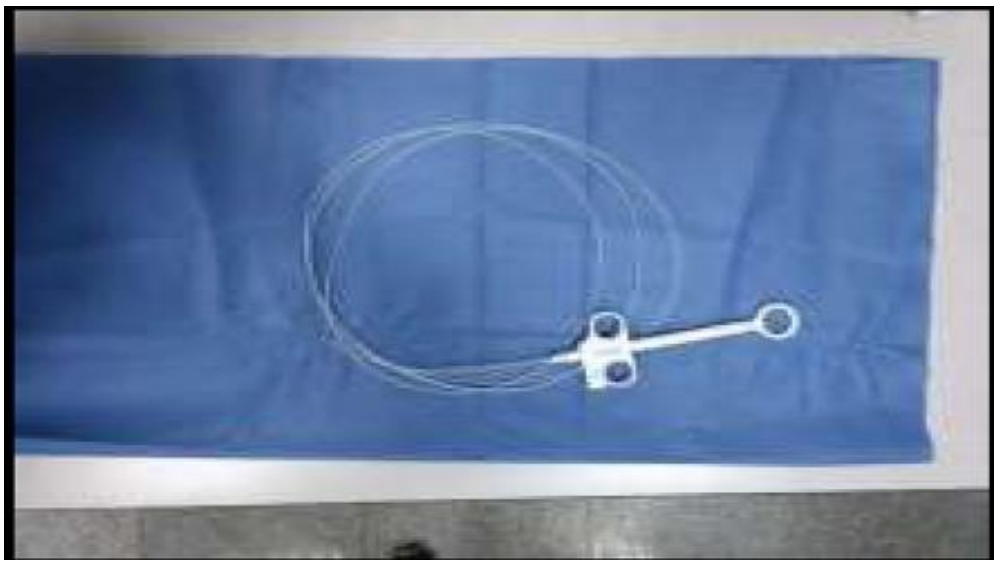

Figure 1: Electrocautery Snare.

Figure 2: Electrocautery probe.

Figure 3: ERBE VIO 300s-Electrosurgical unit and ERBE APC2 V 1-4x.

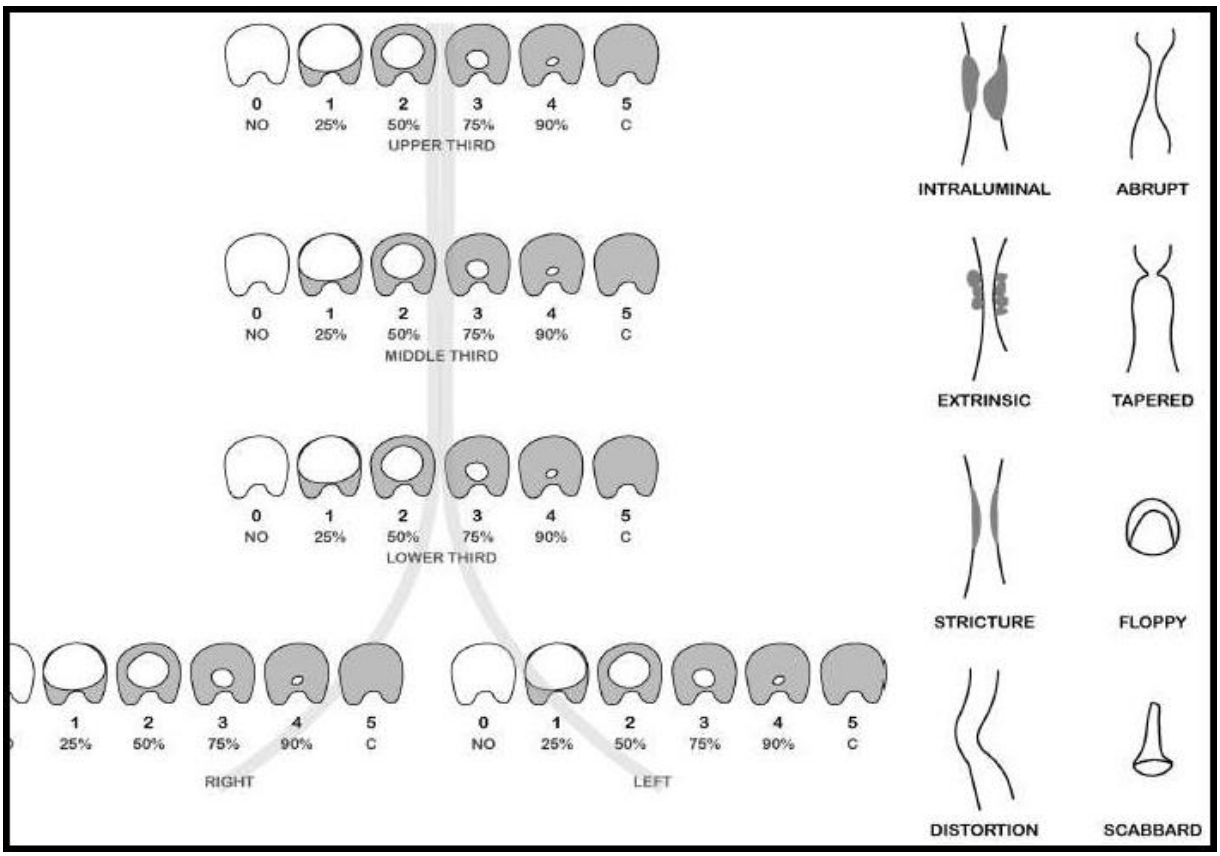

Figure 4: A proposed classification by Freitag L. et al for evaluation of the degree of central airway obstruction.

4. Conclusions

Bronchoscopic electrocautery is a safe and effective ablation method in patients with CAO either for a curative or palliative aim. Symptomatic improvement can be achieved with electrocautery post-procedural with a good restoration of airway patency and a relatively low complication rate. We recommend further multi-center studies to evaluate functional improvement (example: PFTs, 6MWT) and the impact on the QoL.

5. Declarations

5.1. Conflict of interest

The authors declare that they have no conflict of interest.

5.2. Funding

No source of funding.

5.3. Ethical considerations

Study protocol, and written informed consent were submitted for approval from the local ethical committee of Cairo university, and approval was granted with code: (MD-176-2020).

5.4. Acknowledgement

Nill.

6. List of Abbreviations

- **ABG:** Arterial blood gases.
- **CBC:** Complete blood count.
- **CT:** Computed tomography.
- **CXR:** Chest X-ray.
- **EBBT:** Endobronchial brachytherapy.
- **EC:** Electrocautery
- **FB:** Foreign body.
- **INR:** International normalized ratio
- **KFT:** Kidney function test.
- **LFT:** Liver function test.
- **mm Hg:** Millimeter of mercury
- **mMRC:** Modified Medical Research Council
- **MRI:** Magnetic resonance imaging
- **NYHA**: New York heart association
- **PA:** Postero-anterior
- **PFTs:** Pulmonary function tests
- **QoL:** Quality of life
- **SD:** Standard deviation
- **6MWT:** Six-minute walk test

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