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ORIGINAL ARTICLE

Prognostic factors for bronchoscopic electrocautery and/or argon plasma coagulation in patients with central airway obstruction

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KEYWORDS

Therapeutic bronchoscopy;
Central airway obstruction;
Argon plasma;
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Abstract *Background:* Significant portions of central airway stenosis patients present with unresectable disease. Using bronchotherapeutic procedures to maintain a patent airway and improve clinical symptoms and quality of life is a well-known armamentarium technique.

Aim: To assess the contribution of different physiological and pathological prognostic factors on the yield of endobronchial therapies (argon plasma coagulation (APC) and electrocautery) in patients with central airway obstruction whether derived from malignant or non-malignant etiology.

Patients and methods: Twenty nine patients with central airway obstruction, 21 males and eight females, were recruited in the study. All the studied patients were categorized into malignant and non-malignant groups with different pathological varieties. Interventional bronchoscopic procedures were performed under general anesthesia. The flexible bronchoscope was either passed via an endotracheal tube or through the rigid bronchoscope. Collected data included patient demographics, evaluation of performance scale and quality of life status, evaluation of dyspnea, cough and hemoptysis scores before the interventional bronchoscopy and 1 day after the last session. Also the collected data included; length, size, localization and bronchoscopic appearance of the lesion. Duration of symptoms, duration of mechanical ventilation and the presence of collapse prior to the intervention were all recorded. Number of sessions and type of bronchoscopic modalities used were recorded. Spirometric pulmonary function tests were done before and 1 day after the last session.

Results: Complete recanalization was achieved in (17/29) 58.6% of patients, while incomplete or partial recanalization was achieved in (12/29) 41.4% of patients. Using linear regression analysis of

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independent factors affecting patient outcome; it was found that the length of lesion followed by presence of collapse, duration of symptoms and lastly lesion localization whether localized or diffuse ($P < 0.0005$), ($P < 0.011$), ($P < 0.02$) and ($P < 0.039$) were the most independent factors affecting patient outcome.

Conclusion: For favorable outcome, selection of patients with central airway obstructing lesions candidates for bronchoscopic argon plasma coagulation and/or electrocautery should rely on several factors including; age, duration of symptoms, performance scale, co-morbidities, pre-therapeutic FEV1%, presence of lung collapse, and length of the obstructing lesion, moreover its shape and localization.

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Introduction

Despite the many options, the management of airway obstruction from either malignant or nonmalignant causes is a complex problem that requires thorough evaluation by a multidisciplinary team including interventional bronchologists, thoracic surgeons and chest radiologists [1].

With increasing numbers of lung cancer patients, increased need for sophisticated interventions in those patients and the expanding role of the Chest Department, Zagazig University in its surrounding environment; intervention bronchoscopy unit with APC and electrocautery was established on 2008.

The aim of this work is to assess the contribution of different physiological and pathological prognostic factors on the yield of endobronchial therapies (argon plasma coagulation and electrocautery) in patients with central airway obstruction whether derived from malignant or non-malignant etiology.

Patients and methods

Patients

This study was conducted in the Chest Departments (Bronchoscopy Units) of the Ain-Shams and the Zagazig University Hospitals during the period from May 2008 to March 2011. Twenty nine patients, 21 males and eight females, their age ranged from 20 to 67 years with a mean age of 50.45 ± 12.14 years were recruited in the study. Patients gave their signed written consent after detailed explanation of the technique. All the included patients had a diagnosed tracheal, bronchial, tracheobronchial or lobar bronchial obstruction.

Inclusion criteria

The main bulk of the lesion was endobronchial, the obstruction should be at the level of the major airways from the trachea, main bronchi or lobar bronchi, the margin between the lesion and the airway should be identified, patients completed their chemotherapy and/or radiotherapy or did not receive it at all, the tumors had contraindication to surgery either absolute or relative in all included patients, and all patients were suffering from distressing and/or life threatening symptoms related to the airway obstruction. The main symptoms of the patients were severe irritating cough, dyspnea or hemoptysis.

Exclusion criteria

Operable tumors without any contraindications to surgery, presence of severe coagulation defect, orthopedic patients with

severe respiratory distress, patients with extensive myocardial ischemia in ECG, patients with cardiac arrhythmias, or patients with extrabronchial main bulk of the tumor were excluded from the study.

Patients were categorized according to the etiology of central airway obstruction into two groups: Group I: Malignant group which included 21 patients with malignant airway obstruction; they included 17 patients with bronchogenic carcinoma (three of them were having small cell lung cancer (SCLC), 13 patients were having non small cell lung cancer (NSCLC), and one patient with carcinoid tumor), three patients with endobronchial metastatic cancers, and one patient with endobronchial lymphoma. Group II: Non-malignant group which included eight patients with non-malignant central airway obstruction of which; five patients with secondary stenosis to prolonged orotracheal intubation, one patient with tracheal stenosis secondary to tracheostomy, one patient with endobronchial tuberculosis, and one patient with Wegener's granulomatosis (Figs. 1-4). All patients were submitted to:

1. Thorough medical history including smoking habit. History of associated illness like diabetes mellitus, hypertension, ischemic heart disease, history suggestive of COPD and history of tuberculosis. Evaluation of dyspnea: Based on the 5-point dyspnea grading system (The American Thoracic Society dyspnea scale) [2]. Evaluation of cough according to Walsh et al. [3] into the following: Grade 0: No cough Grade 1: Cough does not disturb sleep. Grade 2: Cough disturbs sleep. Evaluation of hemoptysis according to Morice et al. [4]: Grade 0: No hemoptysis. Grade 1: Streaks of blood in sputum. Grade 2: Clots of blood in sputum in 4 days or less during the proceeding 2 weeks. Grade 3: Clots of blood in sputum in 5 or more days during the proceeding 2 weeks. Grade 4: Hemoptysis requires blood transfusion. Evaluation of dyspnea, cough and hemoptysis improvement was done before the interventional bronchoscopy and 1 day after the last session. As regards hemoptysis; daily estimation of the amount of hemoptysis after the procedure was ensured.
2. Full clinical examination: general and local chest examination.
3. Plain chest X-ray (postero-anterior and lateral views), before and after each session of the interventional procedure.
4. Electrocardiography (ECG): It was done before each session of the interventional procedures.

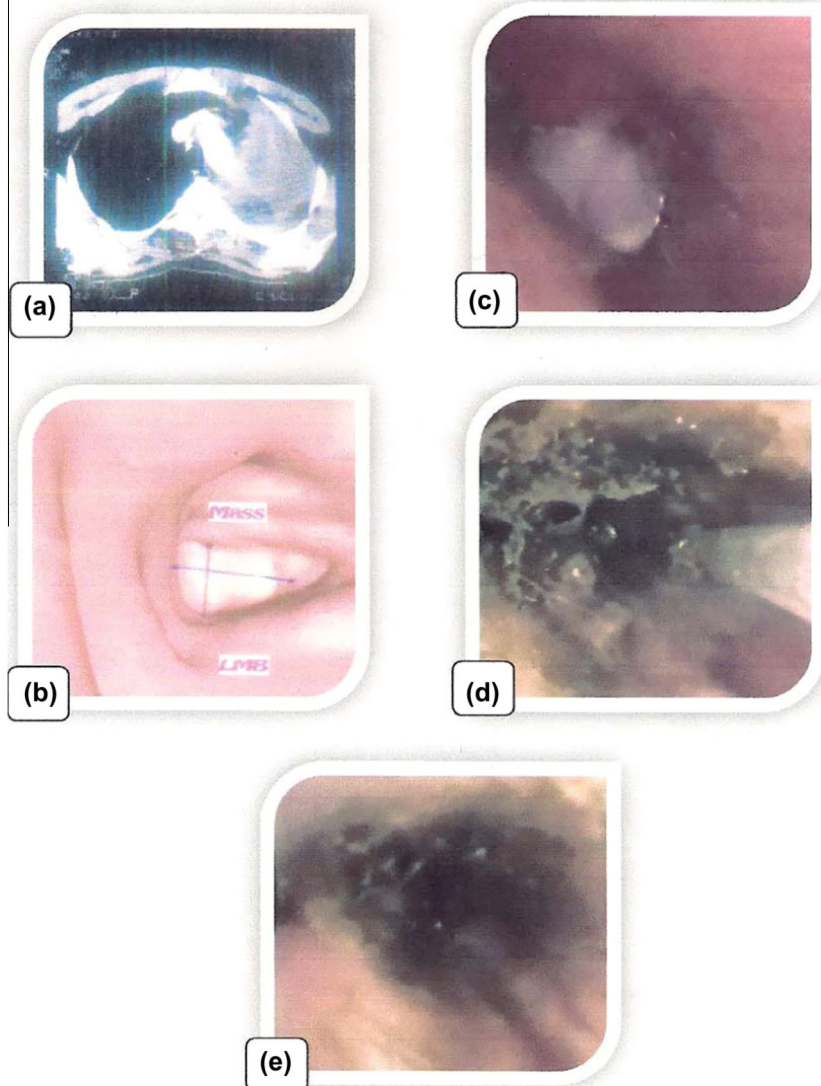
Case No. 17, Left mainstem bronchogenic carcinoma (SCLC),

Figure 1 (a) CT chest mediastinal window demonstrating irregular mass that encroached left main bronchus with distal left lung collapse and left sided pleural effusion. (b) Virtual bronchoscopy showing totally occluded left main bronchus by endobronchial tumor growth. (c) Bronchoscopic view showing left main bronchus occlusion by whitish mass lesion. (d) Devitalized tumor tissue, partial reopening of the left main bronchus, and electrocautery probe. (e) Bronchoscopic view of the partially recanalized left main bronchus after bronchoscopic electrocautery.

5. Laboratory investigations including complete blood picture, prothrombin time, partial thromboplastin time and prothrombin concentration, and liver and kidney function tests.
6. Evaluation of performance and quality of life status; before the procedure and 1 day after the last session. According to the European cooperative oncology group (ECOG) and the World Health Organization (WHO) performance scales and quality of life status [5] were estimated as follows, Score 0: Able to carry out normal activity. Score 1: Restricted in strenuous physical activity but ambulatory and capable of light work. Score 2: Ambulatory and capable of self-care. Unable to work up to 50% of working hours. Score 3: Capable of any limited self-care, confined to bed or chair > 50% of working hours. Score 4: Completely disabled. Cannot carry out self-care and confined to bed or chair. Increasing score means more deterioration.
7. Computed Spiral Tomography and Virtual Bronchoscopy to measure the length and size of the lesion before the interventional bronchoscopy according to Ferretti et al. [6].
8. Flow-volume loop ventilatory function testing according to Braman and Abu-Hijleh [7]: It was performed for all subjects by using computerized pulmonary function apparatus (ZAN 100, computerized pulmonary function apparatus). PFTs were done before the interventional bronchoscopy and 1 day after the last session. The following parameters were obtained: FEV1: Forced expiratory volume in the first second of the beginning of

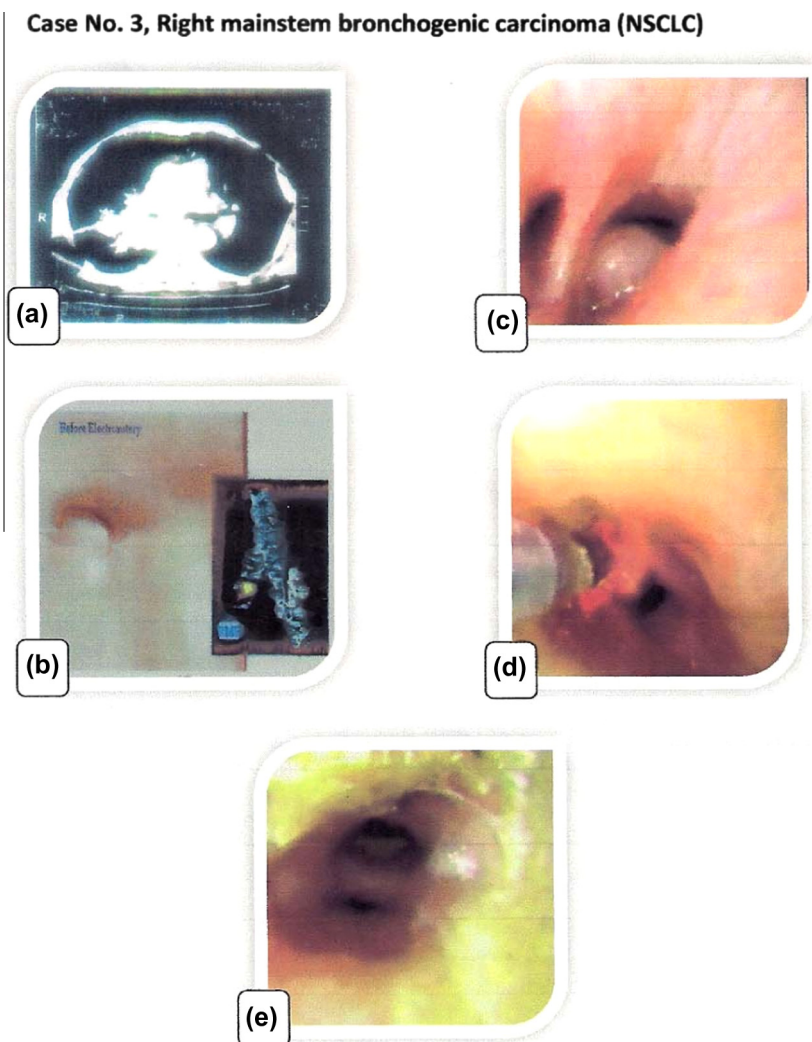


Figure 2 (a) CT chest mediastinal window demonstrating an irregular mass centered at the right hilum. (b) Virtual bronchoscopy showing occlusion of right main bronchus. (c) Fiberoptic bronchoscopic view showing polypoidal mass in the right main bronchus with smooth glistening surface. (d) Electrocautery forceps coagulate and cut the lesion. (e) Bronchoscopic view after the removal of mass leaving areas of blanching surface.

expiration as an absolute value and percentage of predicted for age, sex, length and weight. FVC: Forced vital capacity, absolute value and percentage of predicted. FEV1/measured FVC ratio.

9. Arterial blood gases analysis: This was done before and after the interventional modality according to Lee et al. [8].
10. Interventional bronchoscopic modalities Reichle et al. [9] and Van Boxem et al. [10]: Procedures were performed under general anesthesia. The flexible scope was either passed via an endotracheal tube or through the rigid bronchoscope. Interventional bronchoscopic modalities; APC, endobronchial electrocautery (EES), core out, and dilatation are used singly or in combination according to the obstructing lesion. General anesthesia technique for interventional bronchoscopy is a total intravenous anesthesia, consisting of hypnotic action, analgesia and neuromuscular relaxation. Propofol is a hypnotic drug that was used in a dose of (1–2 mg/kg) for induction and in a dose of (6–10 mg/kg/h) for the

maintenance of anesthesia. Analgesia and muscle relaxation were achieved using fentanyl and succinylcholine. During rigid bronchoscopy, ventilation may be assisted, controlled (IPPV) or manual by hand bag and performed while high flow of air/oxygen is applied through the side port of the rigid bronchoscope. Adequate monitoring is critical to recognize and prevent respiratory or cardiovascular complications. Intraoperative monitoring included continuous pulse oxymetry during every procedure that is carried out under sedation. Furthermore, electrocardiography, and intermittent noninvasive measurement of blood pressure were performed. With the electrocautery, the monopolar probe was pressed against the tumor base and applying 20–40 W of energy until sufficient blanching was apparent. The patient was contacted with a metallic plate near the area of electrocautery application. Inspired oxygen concentrations were kept at 30% if possible. The pulsed mode and low inspired oxygen concentrations were chosen to minimize the risk of unintentional penetrating injury

Case No.29, Tracheobronchial tuberculosis

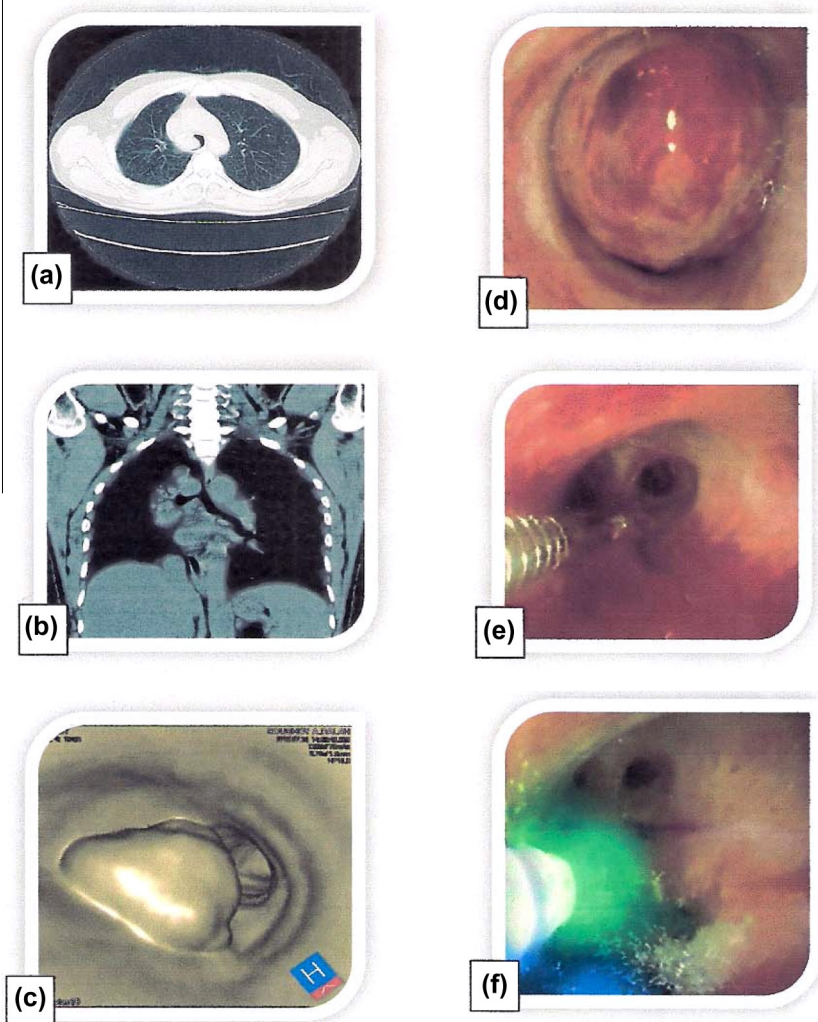


Figure 3 (a) CT chest pulmonary window, showing intra tracheal lesion. (b) Coronal CT cut showing soft tissue attenuation polypoidal mass demonstrated arising from the right side of the tracheobronchial junction. (c) Virtual bronchoscopy view, demonstrating polypoidal mass at lower trachea obscuring right main bronchus with smooth lobulated outline. (d) Bronchoscopic view of trachea showing large mass lesion encapsulated nearly occupying the whole tracheal lumen. (e and f) Electrocautery probe (forceps) at site of lesion during coagulation of the bleeding site and achievement of hemostasis respectively.

or airway fire. Coagulated or vaporized tissues were removed mechanically 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. During treatment with APC, the operator activates the argon gas source and the high frequency surgical unit together in an intermittent way, so that the argon gas passes in the APC probe to be ionized at its distal end by the tungsten electrode. Thereby, a high frequency electrical energy was transmitted to the tissues without contact. The argon gas flow is set at a rate of 0.5–2 L/m and the electrical power from 30 to 50 W. The power settings and the argon gas flow could be increased or decreased by the use of an up and down switch. At retreatment session continued until >75% reopening of the normal airway lumen had been

achieved, or 30 min treatment time elapsed. If there was insufficient reopening due to probable extra luminal compression the session was terminated.

The frequency and intervals of interventional sessions were recorded in each patient besides the time taken in each session and the complications due to the procedure. However, follow up bronchoscopy was routinely done 1 week after each interventional session for evaluation of the changes in the size of the lesion, moreover, removal of the devitalized tissues and debris was also the objective of follow up bronchoscopy in these cases.

Judgement about the degree of reconstruction of the patency of airways was evaluated according to Reitchle et al. [9] as follows:

- (A) Complete success: complete ablation of the endobronchial lesion.

Case No.21, Endobronchial Lymphoma

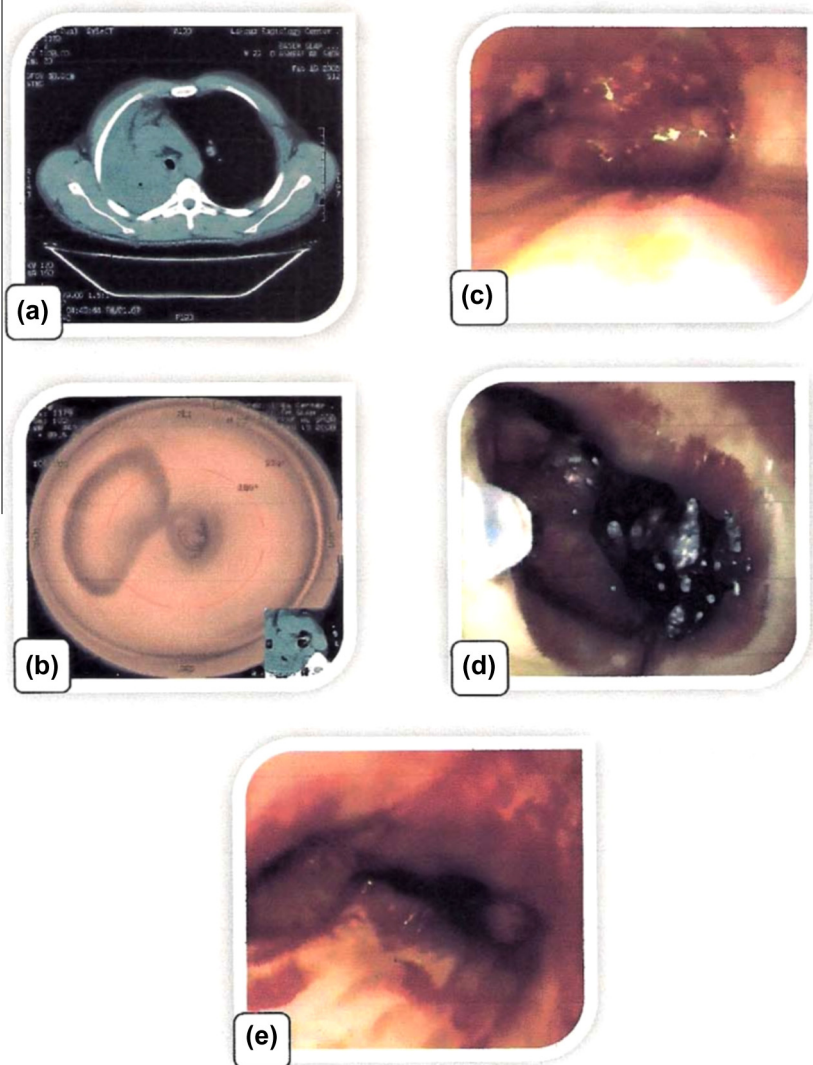


Figure 4 (a) CT chest mediastinal view demonstrating complete collapse of the right lung and intra-tracheal lesion. (b) Virtual bronchoscopy showing endobronchial mass obliterating lumen of right main bronchus. (c) Bronchial view showing mass with lobulated outline, bleed easily on touch extending distally into right main bronchus. (d) Bronchoscopic view of trachea and right main orifice after partial removal of the obstructing lesion. (e) Bronchoscopic view of trachea and right main orifice after partial removal of the obstructing lesion.

- (B) Partial success: more than 50% re-opening of the airway lumen.
- (C) No success: no decrease in the size of the endo-bronchial lesion or less than 50% reopening of the airway lumen.- Patients outcome was assessed according to the findings of follow up bronchoscopy into
 - A. Favorable outcome: complete successful reconstruction of airway patency.
 - B. Unfavorable outcome: partial and/or no success in reconstruction of airway patency.

Statistical analysis

The demographic, clinical, radiological, physiological and pathological data were gathered together with the patient outcome and were tabulated, coded, entered and checked to an Epi-info file using Epi-info version 6.02 computer

packages. Data were summarized using; the arithmetic mean as an average describing the central tendency of observations, the standard deviation (S.D.) as a measure of dispersion of the results around the mean, and the number of observations for each variable studied (N).

Comparison of means: Student's t -test, the Chi-square test (X^2) and linear regression test. Level of significance: For all the above-mentioned statistical tests, the threshold of significance is fixed at the 5% level (P -value), a P -value ≥ 0.05 indicates non-significant results, a P -value < 0.05 indicates significant results, and a P -value < 0.001 indicates highly significant results.

Results

The number of session(s) of endobronchial therapy ranged from 1 to 4, with a median of two sessions applied to sixteen patients (55.2%). One session was applied to three patients

Table 1 Number of session(s) of endobronchial therapy applied to the studied patients.

Number of sessions	Number of patients	Percentage (%)	Median
1	3	10.3	2
2	16	55.2	
3	7	24.2	
4	3	10.3	

while four sessions were applied to three patients only (Table 1).

Table 2 shows that the presence of comorbidities and longer duration of symptoms and longer duration of tracheal intubation are associated with unfavorable outcome. Site of central airway obstruction has non-significant impact on patient outcome.

Table 3 shows that the presence of lung collapse, submucosal lesions, diffuse affection of the airway wall, and increased length and size of the lesion more than 3 cm³ are all associated with unfavorable outcome. Etiology of CAO whether malignant or non-malignant has no impact on the outcome of endobronchial therapy. The total number of cases with favorable outcome is 17 patients (58.6%).

Table 4 shows that the type of the technique used in endobronchial therapy whether Argon Plasma Coagulation, Electrocautery or both have non-significant impact on the outcome of endobronchial therapy. The use of multiple therapeutic endobronchial modalities had higher frequency of favorable patient outcome (76.5%).

Table 5 shows that there is highly significant improvement of dyspnea, cough and hemoptysis scores after endobronchial therapy. There is also a highly significant improvement of performance scale and pulmonary function parameters after endobronchial therapy.

Table 2 The impact of patient related factors on the outcome of endobronchial therapy.

Patient related factors	Favorable outcome		Unfavorable outcome		Total = 29	P-value
	No = 17	%	No = 12	%		
Presence of co-morbidities						
Present	5	29.4	10	83.3	15	0.004*
No comorbidities	12	70.6	2	16.7	14	
Site of CAO						
Trachea	6	35.3	3	25	9	0.85 NS
Rt. Main bronchus	4	23.5	2	16.7	6	0.98 NS
Lt. main bronchus	2	11.8	5	41.7	7	0.15 NS
Bronchus intermedius	3	17.6	0	0.0	3	0.24 NS
Rt or Lt. labor bronchi	1	5.9	2	16.7	3	0.55 NS
Trachea and Rt. Main bronchus	1	5.9	0	0	1	0.85 NS
Duration of symptoms (in weeks)	2.71 ± 1.2		4.92 ± 2.0			0.0011*
Duration of intubation (in days)	9.5 ± 0.7		14.75 ± 3.0			0.03* Sig.

Table 3 Impact of factors related to the lesion on the outcome of endobronchial therapy.

Factors related to the lesion	Favorable outcome		Unfavorable outcome		Total = 29	P-value
	No = 17 (58.6%)		No = 12 (41.4%)			
	No	%	No	%		
Etiology of CAO						
Malignant	12	70.6	21	75	21	0.87
Non-malignant	5	29.4	8	25	8	
Presence of lung collapse						
Presence of collapse	1	5.9	9	66.7	9	<0.001*
No collapse	16	94.1	20	33.3	20	
Bronchoscopic appearance of the lesion						
Polypoidal/exophytic or pedunculated	12	70.6	15	25	15	0.015*
Submucosal	5	29.4	14	75	14	
Localization of the lesion						
Localized	12	70.6	12	0.0	12	<0.001**
Not localized	5	29.4	17	100	17	
Size of the lesion						
< 3 cm ³	16	94.1	19	25	19	<0.001**
> 3 cm ³	1	5.9	10	75	10	
Length of the lesion (cm)	25.82 ± 5.6		40.5 ± 4.4			<0.001**

Table 4 The impact of the technique used in endobronchial therapy on patient outcome.

Technique used	Favorable outcome No = 17 (58.6%)		Unfavorable outcome No = 12 (41.4%)		Total = 29	P-value
	No	%	No	%		
Type of the technique						
APC	8	47.1	7	58.3	15	0.54
EES	8	47.1	4	33.3	12	0.7
Both modalities	1	5.9	1	8.4	2	0.62
Number of modalities						
Single modality	4	23.5	7	58.3	11	0.13
Multiple modalities	13	76.5	5	41.7	18	

Table 5 Dyspnea, cough and hemoptysis scores and performance scales of patient candidates for interventional bronchoscopy before and after procedures.

Variables	Before Mean ± SD	After Mean ± SD	P-value
Dyspnea score	3.28 ± 0.75	1.62 ± 0.68	<0.001
Hemoptysis score	1.28 ± 1.4	0.69 ± 0.26	<0.001
Cough score	1.79 ± 0.41	0.79 ± 0.41	<0.001
Performance scale	2.83 ± 1.26	1.52 ± 1.33	<0.001
Pulmonary function parameters			
FEV ₁ %	52.34 ± 18.23	72.14 ± 19.65	<0.001
FVC%	57.57 ± 24.54	73.72 ± 25.39	<0.001
FEV ₁ /FVC	67.3 ± 19.9	77.52 ± 16.58	<0.001

Table 6 The significance of some independent factors that impact the outcome of patients with central airway obstruction undergoing interventional bronchoscopy.

Independent variables	Coefficient	St. error	T	P value
Constant	-0.8290			
Presence of collapse	0.2917	0.1058	2.756	0.011*
Duration of symptoms	0.05427	0.02178	2.492	0.0200*
Length of lesion	0.02552	0.00632	4.039	0.0005*
Localized to wall	0.2419	0.1109	2.181	0.0392*

Using the linear regression analysis of independent factors affecting the patient outcome; the length of the lesion was the most independent factor affecting outcome ($P = 0.0005$) followed by the presence of collapse ($P = 0.011$), duration of symptoms ($P = 0.02$) and lastly lesion localization ($P = 0.039$) whether localized or diffuse [Table 6](#).

Discussion

Therapeutic bronchoscopy has offered several alternatives to conventional therapy to overcome endobronchial obstruction which has a central location in 50% of patients with lung cancer. These bronchoscopic modalities can be life saving, offer clinical stability that may allow additional cancer treatment [\[11\]](#).

In interventional pulmonology, various available methods can currently be applied. Hot techniques achieve rapid hemostasis enabling mechanical debulking of obstructing tumors. These combinations of techniques have become the corner-

stone approach for immediate recanalization. Cryotherapy, brachytherapy and PDT are, therefore, less appropriate. Electrocautery and argon plasma coagulation are straightforward techniques enabling simpler clinical application than Nd-YAG laser. From the clinical perspective, immediate symptomatic relief by tumor coagulation using electrocautery followed by mechanical debulking is straightforward and has been the accepted consensus strategy [\[12\]](#).

Patients were enrolled in this study after the completion of chemotherapy and/or radiotherapy course(s) or not receiving them at all, thus the changes in their QOL are solely on the basis of re-establishment of central airway patency.

In this work, co-morbidities were found in 15/29 (51.72%) of all the studied patients, COPD was the most common figure among them. These co-morbidities, longer duration of symptoms and longer duration of mechanical ventilation were significantly associated with unfavorable outcome ([Table 2](#)). Smoking, chronic obstructive pulmonary disease (COPD) and malignant obstruction of the airways are commonly found to be a leading cause of impact on patient outcome in many studies, furthermore, in previous studies; some of their patients had coexisting moderate-to-severe COPD and still showed physiologic and clinical improvement after therapeutic bronchoscopic resection of their obstructive large airway lesions [\[10\]](#).

In the current study, number of sessions ranged from 1 to 4, with a median of two sessions ([Table 1](#)) each lasting about 30 min. The interval between the sessions during the course of this study was 1 week in the majority of cases and this interval was also recommended [\[12\]](#). Morice et al. [\[4\]](#) and Reichle et al. [\[9\]](#) reported a lower mean of session number being 1.2 and 1.4, respectively. On the contrary, the mean number of sessions reported was relatively higher than current work number of sessions being 3.5 sessions [\[13\]](#). Yasuo et al. [\[14\]](#) treated post intubation granulation tissue using APC with a session number range 3–4. The experience of Keller et al. [\[15\]](#) was unique as they performed APC in most of their series in only one session but did not deny that in a few situations, they may be in need for up to five sessions. On the other hand, the range of duration of each APC session was relatively more than Crosta et al. [\[13\]](#) being 15–40 min in their experience. Mohammad et al. [\[16\]](#), reported a need for a number of APC sessions ranging between 1 and 4 with a mean of two to achieve the required palliative effect with a mean duration of 45 min in each session ([Fig. 5](#)).

In this study, favorable outcome was linked to complete success (e.g. complete ablation of the endobronchial lesion), while partial and/or no success in the reconstruction of airway patency

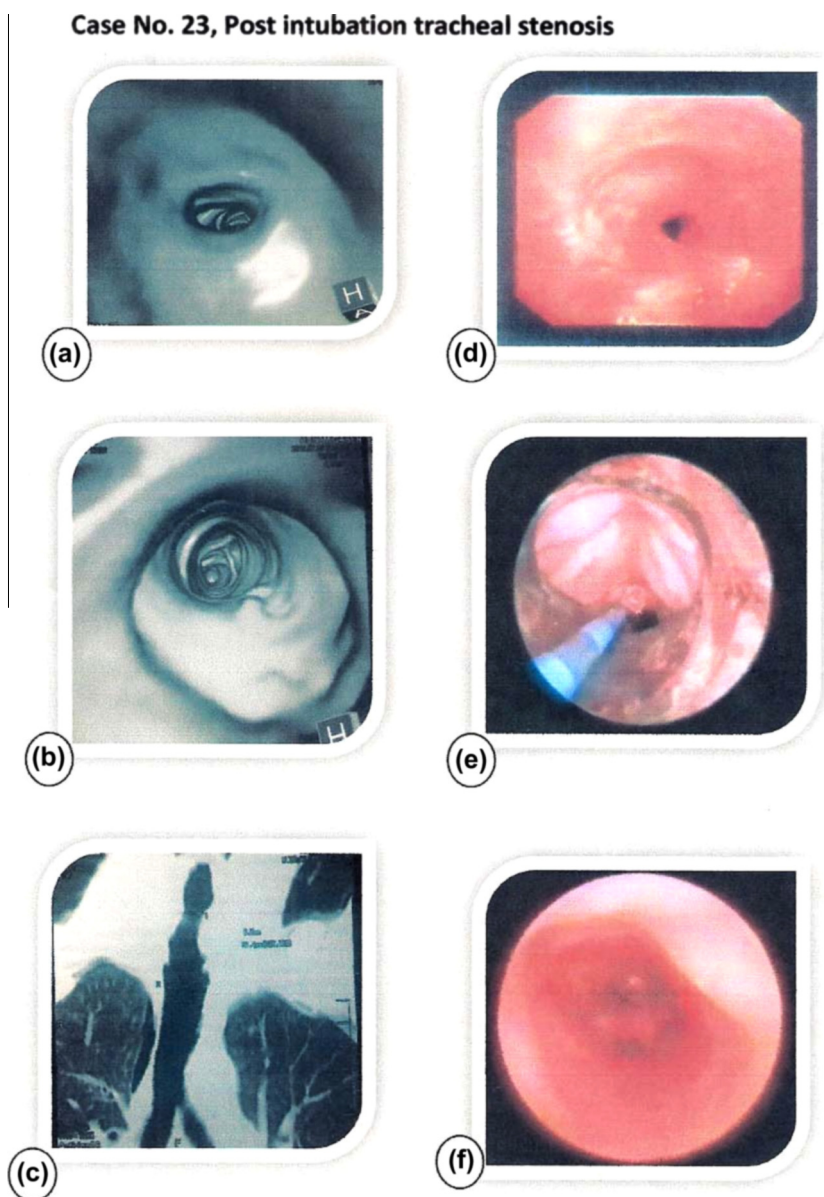


Figure 5 (a and b) Virtual bronchoscopy view into trachea; (a) at the site of stenosis and (b) below the narrowed segment, when the trachea had regained normal caliber. (c) Coronal CT cut demonstrating the narrowest diameter of 8.9 mm and post stenotic diameter of 21.4 mm. (d) Fiberoptic bronchoscopy view showing the pin point tracheal stenosis. (e) Argon plasma coagulation probe and rigid bronchoscope at the stenotic segment. (f) Bronchoscopic view of trachea after removal of granulation tissue and rigid bronchoscopic dilatation.

was interpreted as unfavorable prognosis. Complete recanalization was achieved in (58.6%) while unfavorable outcome accounted for (41.4%) among all the studied patients (Table 3).

The success rate recorded in this study was comparable to the success rate reported by Vergnon et al. [17] and Yousef [18], who achieved (65%) and (55%) success rates with cryotherapy respectively. Macho et al. [19] reported that, of the 75 patients who underwent endobronchial recanalization by laser resection, in 14% no recanalization was achieved, in 50% partial (>50% of the lumen) recanalization was obtained, while in 36% full opening of the occluded bronchus proved possible. In the study of Lyu et al. [20] successful recanalization, with cryotherapy, was achieved in 11 patients (37%), and partially successful response was achieved in 15 patients

(50%). Reichle et al. [9] reported a lower incidence of complete recanalization (7%) and (40%) failure rate with APC treatment. This result may be explained by an inexperienced bronchoscopist as they reported several complications with technical aspects or severe underlying disease and large tumor size, and deep extension of the lesion.

In the study of Mohammad et al. [16], the success rate of the bronchoscopic modalities in reconstruction of the patency of the airways was only considered when more than 50% of the visible tumor is destroyed. He achieved 85% success rate, partial recanalization in 15% of cases, with no failure rate. This finding may clarify the cause of higher rates of success in his work as in the current study complete recanalization was considered only if 100% patency was restored.

In this work; on studying of the impact of factors related to the endobronchial lesion on patient outcome; there was no significance in success between malignant and non-malignant etiologies of centrally obstructing lesions (Table 3). In agreement with Colt [21] opinion, patients with benign causes of airway obstruction may also present too late. The interventional bronchoscopist's mission is first to restore airway patency, and second to assess the potential for curative bronchoscopic or open surgical treatment in those patients. Emergency interventional procedures in this setting are usually life saving, allowing patients to calmly participate in subsequent decision making regarding further treatment options.

In this work, post-intubation and tracheostomy tracheal stenosis account the most popular reasons of non-malignant CAO (6/8 cases). For all of them, APC and bronchoscopic dilatation were applied. In the present study; it was found that presence of lung collapse, submucosal lesions, larger length and size of the lesion with diffuse affection of the airway wall are all associated with unfavorable outcome. Coulter and Mehta [22] found that lesions found to be most favorable to interventional therapeutic bronchoscopy were polypoid in morphology and were attached to the airway by a stalk. This characteristic finding allowed for the total ensnarement of the lesion with complete removal in one piece. In addition to the immediate difficulties of treating sessile lesions, late complications can occur as well. The various settings of mode, power, and duration of application make it difficult to predict the depth of tissue destruction.

Supportive results were published in many previous studies, as tumors > 1 cm, with > 3 mm invasion of the bronchial mucosa and invisible distal tumor margin are unlikely to be cured by bronchoscopic treatment [23]. In a pilot study, Van Boxem et al. [10] reported a complete response to EBES in 10 of 13 patients with endobronchial lesions that were < 1 cm². Their study suggests that EBES may be an effective alternative even in the treatment of carcinoma in situ.

In the present study, it was found that the type of the technique used in endobronchial therapy whether electrocautery or argon plasma coagulation or both had non-significant impact on patient outcome. This can be explained by the fact that both modes of endobronchial therapy produce the same effect of thermal electrocoagulation, one of them (electrocautery) applies the contact mode while the other (APC) applies the non contact mode of tissue coagulation. In the present study, the use of multiple modalities of endobronchial therapy has statistically non-significant higher frequency of favorable outcome (76.5%) (Table 4). The multiple modalities used in this work are; tissue core out, rigid bronchoscopic dilatation, APC and EES.

In the present work there was highly significant improvement of dyspnea, cough and hemoptysis scores after endobronchial therapy. There was also highly significant improvement of performance scale and pulmonary function parameters after endobronchial therapy (Table 5). Amjadi et al. [24] concluded that in the appropriate patient population, interventional bronchoscopy can provide a significant improvement of respiratory symptoms and quality of life in malignant airway obstruction. Mohammad et al. [16] reported significant improvement in FVC% even after the first session of APC treatment with a significant improvement in FEV1% and FEV1/FVC% but only after the last session.

Using the linear regression analysis of independent factors affecting the patient outcome; it was found that; length of the lesion was the most independent factor affecting the outcome ($P = 0.0005$), followed by the presence of collapse ($P = 0.011$), duration of symptoms ($P = 0.02$) and lastly lesion localization ($P = 0.039$) whether localized or diffuse (Table 6). This result agrees with that of Coulter and Mehta [22].

Conclusion

Argon plasma coagulation (APC) and electrocautery are safe and effective modalities in alleviating symptoms, improving performance, quality of life and ventilatory function parameters in patients with central airway obstruction. For favorable outcome, selection of patients with central airway obstructing lesions candidates for bronchoscopic argon plasma coagulation and/or electrocautery should rely on several factors; age, duration of symptoms, performance scale, co-morbidities, pre-therapeutic FEV₁%, presence of lung collapse, and length of the obstructing lesion, moreover its shape and localization.

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