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ORIGINAL ARTICLE

Safety and effectiveness of microdebrider bronchoscopy for the management of central airway obstruction

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ABSTRACT

Background and objective: **Microdebrider bronchoscopy is a relatively new modality for the management of central airway obstruction (CAO) of both benign and malignant origin. Our objective was to describe our experience with this technique, with special attention to its safety and effectiveness.**

Methods: **We retrospectively reviewed cases of therapeutic bronchoscopies using microdebrider for CAO from two institutions (M.D. Anderson Cancer Center and Michael E. Debakey VA Medical Center, Houston) from August 2008 through February 2012.**

Results: **We identified 51 cases. Malignant CAO was detected in 36 cases (71%): non-small-cell lung cancer (n = 22), melanoma (n = 3), small-cell-lung cancer (n = 2), thyroid cancer (n = 2), esophageal carcinoma (n = 2), breast cancer (n = 2), and others (n = 3). Benign diseases included: papillomas (n = 8), granulation tissue (n = 3), and others (n = 4). Obstruction was purely endoluminal in 32 cases (63%). Pre-treatment obstruction was severe in 25 cases (49%), moderate in 20 cases (39%) and mild in 6 (12%). Lesions were located in the trachea (n = 23), main stem bronchi (n = 25), and bronchus intermedius (n = 8), with some patients having more than one lesion. After tumor debulking with microdebrider, the residual airway obstruction was insignificant (n = 27 cases; 53%), mild (n = 23 cases; 45%), and moderate (n = 1; 2%). No major complications were encountered, only 2 patients had mild adverse events: one case of pneumomediastinum, and one self-expandable stent damage requiring its removal. Two patients (4%) died within 30 days of causes unrelated to the procedure or the CAO.**

Conclusions: **Microdebrider bronchoscopy is a potentially safe and effective way to manage central airway obstruction of both malignant and benign origin.**

SUMMARY AT A GLANCE

Microdebrider bronchoscopy is a relatively new tool in interventional pulmonology. To date, there are no data on its safety and effectiveness, particularly for malignant CAO. Our study has found this modality to be highly effective and with a favourable safety profile.

Key words: airway obstruction, bronchoscopy, interventional bronchoscopy, lung cancer.

Abbreviations: APC, argon plasma coagulation; CAO, central airway obstruction.

INTRODUCTION

Central airway obstruction (CAO) represents a great challenge to physicians from all subspecialties who manage thoracic diseases. A wide variety of malignant and non-malignant processes can cause CAO.[1] Complications associated with endobronchial disease develop in approximately 20 to 30 % of the 200 000 cases of lung cancer diagnosed in the United States yearly, resulting in reduced quality of life for these patients.[2,3] Additionally, it is estimated that up to 40% of lung cancer deaths are related to advanced locoregional disease.[3,4] Airway obstruction caused by benign processes has also increased over the last decade, probably as a result of the growing number of artificial airways used in clinical practice, such as endotracheal intubation and tracheostomy.[5,6] Regardless of the aetiology, obstruction of the central airways often constitutes a complex life-threatening disorder requiring immediate assessment and intervention.

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Therapeutic bronchoscopy has proved to be highly effective in recanalizing the airways, providing symptom relief, improving quality of life, and in some cases, improving survival.[7,8] Bronchoscopic modalities available can be divided in those with 'immediate effect' (thermal ablation such as laser, contact-electrocautery or argon plasma coagulation (APC); mechanical debulking with rigid bronchoscope and stent placement) and those with 'delayed effect' (brachytherapy, cryotherapy, photodynamic therapy). Each one of these techniques has its own advantages and disadvantages.[9–11] Microdebriders are one of the newest additions to the armamentarium of interventional pulmonologists. Microdebriders are powered instruments composed of a hollow metal tube with a rotating bit or blade coupled with suction which can only be utilized through rigid bronchoscopes or tracheoscopes.[12] Although they have been used for over a decade in the otorhinolaryngology field, data on efficacy and safety for the management of CAO are scarce, particularly for malignant disease.[13] We describe clinical experience with microdebrider bronchoscopy, in terms of efficacy of airway recanalization and safety for both malignant and non-malignant CAO.

METHODS

We conducted a retrospective chart review of patients with CAO who underwent therapeutic bronchoscopy with microdebrider at Michael E. DeBakey VA Medical Center and MD Anderson Cancer Center, between August 2008 and February 2012. Institutional Review Board approval was in place in both institutions before the review of these charts commenced, and patients' confidentiality was maintained. We extracted patients' demographics and relevant clinical data, including: history of haemoptysis, bleeding diathesis, local radiotherapy and airway stenting to the affected segment. Detailed description of lesions during the procedure included: macroscopic appearance, anatomical location, degree/type of obstruction and involvement of posterior membranous wall. The percentage of airway obstruction documented by the bronchoscopist was estimated by visual comparison between the affected area and the healthy proximal airway. We defined it as severe (> 70%), moderate (30–70%), mild (<30%) or insignificant (<10%). Post-procedure degree of airway obstruction was estimated in the same fashion. In all cases, definitive tissue diagnosis was achieved by pathological confirmation. Either a biopsy was taken with a forceps prior to debulking with microdebrider, or the canister with the material suctioned by the microdebrider was sent to pathology. Microdebrider bronchoscopy was performed using Straightshot M4 Microdebrider, powered by Integrated Power Console (Medtronics-Xomed, Jacksonville, FL, USA) inserted through a rigid bronchoscope or tracheoscope under general anaesthesia with jet ventilation. Direct visualization during debulking was provided by a 0-degree rigid telescope inserted through the rigid bronchoscope in parallel

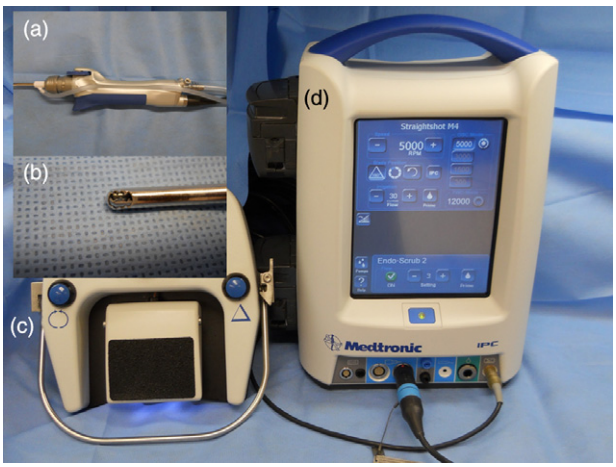

Figure 1 Straightshot M4 Microdebrider, powered by Integrated Power Console (Medtronics-Xomed, Jacksonville, FL, USA). (a) Hand-piece. (b) Blade-tip. (c) Foot pedal. (d) Power console.

to the microdebrider. The microdebrider instrument is composed of a hollow metal tube with a rotating blade or bit coupled with suction.[14] The instrument is 45 cm long and 4 mm wide, allowing it to reach lesions in the trachea, main stem bronchi and bronchus intermedius.[15] The tip of the microdebrider can be either straight or 15° angled, and the blades smooth or serrated, depending on the needs of the particular case at hand (Fig. 1). The operator controls the device through the hand-piece coupled with a flywheel that allows 360° rotation of the tip. This unique feature allows the blade to be rotated with a fingertip instead of having to turn the entire handle. The power source console allows adjustment of the speed measured as rpm, typically set at a rate between 1500 and 5000. The lower the rpm, the more tissue is drawn into the blade gap, facilitating more tissue removal. Once the device is activated through a foot pedal, the rotating blade is manoeuvred to make gentle contact with the surface of the tumour, allowing the suction to bring the tissue into it. Prompt removal of debris and blood through suction channel provides a clear visualization of the operative field.

We also recorded the use of any supplementary bronchoscopic techniques for airway recanalization such as APC, cryotherapy, electrocautery, laser and stent placement. Data gathered on complications and adverse events related to microdebrider bronchoscopy were gathered and included: significant bleeding (defined as inadequate spontaneous haemostasis that required additional endoscopic therapies); airway perforation; need to repeat bronchoscopy for additional tumour debulking or clinically significant haemoptysis—both within 30 days of initial therapeutic bronchoscopy. Mortality at 30 days was also analysed. Both institutions have in place a tracking system for procedure-related complications created prior to this study for quality improvement purposes. Statistical data are presented in tables as absolute number of cases, means and percentages.

Table 1 Patient characteristics

Description	Values
Age (median)	70 (range 41–76)
Gender	
Male	38 (75%)
Female	13 (25%)
Malignant CAO	36 (71%)
NSCLC	22
Melanoma	3
Breast cancer	2
Esophageal cancer	2
Thyroid cancer	2
SCLC	2
Carcinoid	1
Colon cancer	1
Renal cell carcinoma	1
Non-malignant CAO	15 (29%)
Tracheal papillomas	8
Granulation tissue	3
Tracheal schwannoma	1
Amyloid	1
Hamartoma	1
Granulomatous inflammation	1
Haemoptysis prior to procedure	14 (27%)
Location	
Trachea	23
Main bronchus	
Right main stem	19
Left main stem	10
Bronchus intermedius.	8
Posterior wall involvement	33 (65%)

CAO, central airway obstruction; NSCLC, non-small-cell lung cancer; SCLC, small-cell lung cancer.

Table 2 Degree of obstruction pre and post microdebrider debulking, additional therapies and complications

	Pre-procedure	Post-procedure
Mean degree of obstruction	71%	10%
Severe†	25 (49%)	0 (0%)
Moderate†	20 (39%)	1 (2%)
Mild†	6 (12%)	23 (45%)
Insignificant†	0	27 (53%)
Additional endobronchial therapies†‡		
APC	32 (63%)	NA
Airway stenting	13 (25%)	NA
Electrocautery	10 (20%)	NA
Laser	5 (10%)	NA
Cryotherapy	5 (10%)	NA
Adverse events†		
Significant bleeding	0	NA
Pneumomediastinum	1 (2%)	NA
Stent damage	1 (2%)	NA
Repeat bronchoscopy	0	NA

† Values are presented as number of patients and percentages of the study population.

‡ Some patients had more than one additional technique.

NA, not applicable; APC, argon plasma coagulation.

RESULTS

We identified a total of 51 cases. Patients' demographics, diagnosis, clinical data and characteristics of CAO are shown in Table 1. CAO was secondary to malignant disease in 36 cases (71%). The most common malignancies encountered were: non-small-cell lung cancer ($n = 22$), followed by melanoma ($n = 3$), small-cell lung cancer ($n = 2$), esophageal carcinoma ($n = 2$), breast cancer ($n = 2$) and thyroid cancer ($n = 2$) (Table 1). Haemoptysis was present at baseline in 41% of all malignant cases. Non-malignant aetiologies included: papillomas ($n = 8$), granulation tissue ($n = 3$), tracheal amyloid ($n = 1$), tracheal schwannoma ($n = 1$), tracheal hamartoma ($n = 1$) and granulomatous inflammation ($n = 1$).

Lesions were located in trachea ($n = 23$), left main stem bronchi ($n = 10$), right main stem bronchi ($n = 19$) and bronchus intermedius ($n = 8$), with some patients having more than one lesion. The mean pre-treatment airway obstruction was 71%; distributed as severe ($n = 25$ cases; 49%), moderate ($n = 20$ cases; 39%) and mild ($n = 6$ cases; 12%) (Table 2). The posterior membranous wall was involved in 33 cases (65%). Although the majority of the obstructions were purely endoluminal ($n = 32$ cases, 63%), simultaneous extrinsic compression was also found in 19 cases (37%).

After tumour debulking with microdebrider bronchoscopy, the residual mean airway obstruction was 10%; distributed as insignificant ($n = 27$ cases; 53%), mild ($n = 23$ cases; 45%) and moderate ($n = 1$; 2%). Examples of airway obstruction pre and post debridement are illustrated in Figure 2.

Within the same bronchoscopic procedure, after primary tumour debulking with microdebrider, most patients received additional endoscopic therapies including: APC ($n = 32$ cases), endobronchial stenting ($n = 13$ cases) and electrocautery ($n = 10$ cases). None of the cases of APC or electrocautery were done for bleeding control. The documented indication was to destroy the base of the tumour or to treat additional lesions in more distal airways that could not be reached with the rigid bronchoscope.

Adverse events were reported in two patients (4%). The only intraoperative complication was the damage of a self-expandable stent after it was caught by the microdebrider blades, requiring its removal. One patient developed pneumomediastinum a few hours after the procedure. The patient was managed conservatively and pneumomediastinum resolved within a few days. None of the patients required additional bronchoscopies. Two patients (4%) died within 30 days of the procedure, but neither event was associated to the patients' airway obstruction or to the procedure.

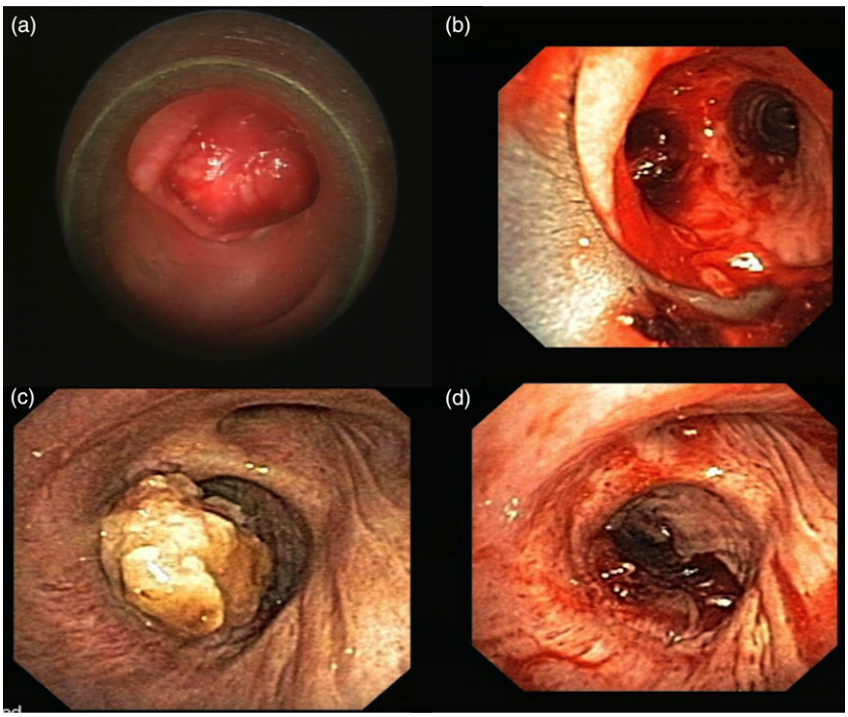

Figure 2 (a) Distal tracheal mass due to small-cell lung cancer producing severe obstruction. (b) Status post debridement of the distal tracheal mass observed in 'a', with insignificant residual obstruction. (c) Adenocarcinoma of the lung producing moderate obstruction of right bronchus intermedius. (d) Status post debridement of the right bronchus intermedius tumour observed in 'c', with minimal residual obstruction.

DISCUSSION

The use of microdebrider bronchoscopy for the management of CAO is relatively new and data on effectiveness and safety are limited, particularly for malignant disease. After Lunn's initial feasibility study—which included only three patients with malignant CAO—there has not been any further relevant literature on this topic, except for anecdotal case reports.[12,14–16] To the best of our knowledge, this is the largest study on microdebrider bronchoscopy providing evidence on its safety and efficacy for the management of both benign and malignant CAO.

In our study, almost 50% of the patients had severe airway obstruction, representing a high-risk population prone to develop suboptimal oxygenation and ventilation intraoperatively. In this population, the microdebrider offers a clear advantage over thermal ablative techniques (such as cautery, APC and laser), in that the modality does not require lowering of the FiO_2 or interruption of jet ventilation to avoid endobronchial fire. This advantage may be particularly important when dealing with critical CAO and marginal oxygenation and ventilation.[15]Additionally, the coupled suction allows the microdebrider to be used continuously without having to be removed and reintroduced for tumour debulking like most other bronchoscopic tools (forceps, electrocautery probes), potentially shortening the duration of the procedure as compared with other modalities. This advantage has already been described in the paediatric literature, where the use of microdebrider for excision of benign laryngeal lesions have been shown to significantly reduce the length of the procedure by an average of 10 to 30 min.[5,17]

The microdebrider modality showed considerable effectiveness in our study. After tumour debulking with microdebrider, the mean airway obstruction was 10%, which accounts for a total mean reduction of 61%. This outcome is comparable with the effectiveness of APC and laser in terms of airway recanalization.[7,10] In our study, none of the patients required further bronchoscopies for endobronchial interventions within 30 days of initial treatment with microdebrider.

Additional bronchoscopic techniques such as APC, stenting or cryotherapy, were utilized in combination with microdebrider in several of our patients. Except for airway stents (utilized to prevent re-obstruction of the airway or to treat extrinsic compression), the rest of the techniques were mainly utilized to destroy the base of the tumour that had been debulked with the microdebrider, or to treat additional lesions located in more distal airways—which could not be reached with the rigid bronchoscope. To prevent airway wall perforation, once the fungating endoluminal component of a tumour was debulked with microdebrider, some bronchoscopists in our group utilized APC to destroy what was left of the tumour at the level of the airway wall. The primary tumour debulking method which relieved the obstruction was the microdebrider in all our cases.

Safety is a vital component of any bronchoscopic device. The overall rate of adverse events associated with traditional ablative techniques ranges between 3 and 17%.[1,18,19] However, to date, there has not been any substantial data on the potential complications associated with the use of microdebrider. We encountered no major complications and a low rate of mild adverse events (4%). Finally, despite dealing with large

malignant tumours and roughly a third of patients with previous haemoptysis, we had no significant issues with bleeding.

Several techniques are available for the management of CAO and current recommendations support a multimodality approach emphasizing the combination of several endobronchial interventions to achieve best results.[1,3,9,10] The cost of the microdebrider equipment is not greater than that of other bronchoscopic tools used for tumour debulking, making the microdebrider a relatively affordable tool for any interventional pulmonology or thoracic surgery programme.

A possible limitation of the microdebrider is the need of rigid bronchoscopy and general anaesthesia. However, its use could be reserved for institutions with high expertise in management of CAO, where rigid bronchoscopy is typically a standard procedure. Another drawback of this technique is that it can only reach the trachea, main bronchi and bronchus intermedius, not allowing debulking of more distal disease.

A major limitation of our study is its retrospective nature. However, conducting a randomized control trial to establish which modality is superior would be extremely difficult. Another relevant limitation is the lack of objective measurement such as pretreatment and post-treatment lung function tests, 6-min walk or dyspnoea scores. Due to the retrospective nature of the study, these data were only available in some patients, and hence it was not reported.

In conclusion, microdebrider bronchoscopy is a potentially safe and effective technique to manage CAO of both benign and malignant origin. This study should prompt prospective trials employing this technique.

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