

Endobronchial Stenting in Patients Requiring Mechanical Ventilation for Major Airway Obstruction

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Abstract

Objective: To examine the value of therapeutic rigid bronchoscopy on subsequent ventilator weaning in ventilated patients with major airway obstruction. **Materials and Methods:** Retrospective review of the medical records of patients who were receiving mechanical ventilation up to the time of rigid bronchoscopy over the period from September 1994 to January 1999. The setting is in an acute tertiary hospital. All patients underwent rigid bronchoscopy with endoscopic techniques (forceps removal, balloon dilation, Nd:YAG laser resection and stent insertion) aimed at restoration of major airway patency. **Results:** Seven patients were identified; 2 with benign stenosis and 5 with malignant stenosis. Six out of the 7 patients had presented with acute respiratory distress requiring emergent intubation, whilst 1 patient had extubation difficulties following general anaesthesia with endotracheal intubation. Three out of the 7 patients had previously failed extubation attempts. All 7 patients were successfully extubated within 48 hours following the procedure. **Conclusions:** Therapeutic rigid bronchoscopy is effective in the acute management of respiratory distress from central airway obstruction. Dramatic improvements in ventilatory status following therapeutic rigid bronchoscopy allow ventilator liberation in a select group of patients with an otherwise good performance status.

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Key words: Extubation, Respiratory distress, Rigid bronchoscope, Ventilator weaning

Introduction

Few things are as dramatic as respiratory arrest from major airway obstruction. Major airway obstruction frequently leads to well-defined clinical sequelae, namely shunt-associated hypoxaemia and post-obstructive pneumonia. In its chronic form, it leads to hypoventilation, hypoxaemia, hypercarbia, pulmonary hypertension and cor pulmonale.¹ Given a) its relative rarity by comparison with other obstructive airway disorders, b) the insensitivity of routine chest roentgenograms in detecting significant airway obstruction,^{2,3} and c) the heterogeneity of pulmonary function data,⁴ there is often a delay in diagnosis. It is therefore not unusual for patients with major airway obstruction to first present to the hospital in-extremis requiring emergency endotracheal intubation prior to establishing the diagnosis.

The last decade has seen a proliferation of effective endobronchial techniques to restore luminal patency in the central airways. Among the available options, Nd:YAG laser photoresection and stenting are popular for its rapidity of effect, and low rate of immediate complications.⁵⁻⁷ Since 1994, our department has offered Nd:YAG laser

photoresection, mechanical dilation (balloon and rigid tubes) and airway stenting for symptomatic patients with major airway obstruction with no other definitive treatment options. We were interested in the impact of therapeutic rigid bronchoscopy on the immediate ventilator course in patients with major airway obstruction, and discuss its potential as adjunctive therapy to facilitate extubation.

Materials and Methods

The records of all patients who underwent therapeutic rigid bronchoscopy to address major airway obstruction in our institution between September 1994 and January 1999 were retrospectively reviewed. Out of the 105 patients, 7 were receiving mechanical ventilation up to the time of interventional rigid bronchoscopy. These 7 patients formed the study group. Our study aim was to analyse the effects of therapeutic bronchoscopy on successful ventilator weaning. Flexible fiberoptic bronchoscopy was performed on all 7 patients to assess the airway stenosis prior to rigid bronchoscopy. All 7 patients subsequently underwent rigid bronchoscopy and endoscopic therapy aimed to restore luminal patency and facilitate extubation. Therapeutic

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rigid bronchoscopy was performed in the operating theatre under intravenous anaesthesia and spontaneous assisted ventilation. Endoscopic therapy included manual coring of exophytic lesions with the rigid bronchoscope, forceps removal, balloon dilatation, Nd:YAG laser resection and stent placement. Laser power was applied at 30 watt/pulse with pulse duration of 0.5 seconds. Prosthetic stents were inserted for patients with predominantly extrinsic airway compression or airway malacia, and prophylactically inserted in all patients following tumour debulking or laser photocoagulation. All stents used were of DUMON silicone prosthesis (Fig. 1) except for 1 patient who required metallic Wallstents. Data extracted from the medical records included age, sex, level and aetiology of the airway stenosis, the procedure performed, the airway calibre before and after the therapeutic measures, complications, rates of ventilator liberation and eventual status as of March 1999.

Results

The clinical characteristics of the 7 patients are summarised in Table I. Of the 7 patients, 4 were females and 3 males with a mean age of 58 years (range 40 years to 80 years). The decision for endotracheal intubation was left

at the discretion of the attending physician. Of the 7 patients referred for therapeutic bronchoscopy, 6 patients (#1 to #6) were intubated acutely for current or impending respiratory failure, whilst patient #7 was referred to us for extubation difficulties encountered following elective intubation for ventriculo-peritoneal shunt insertion. Two patients had a benign cause of airway obstruction (Fig. 2), from active or prior tuberculous disease, whilst 5 patients had malignant stenoses. The most common site of airway involvement was the trachea, with sole tracheal involvement in 3 patients, and mixed involvement, i.e. tracheal and mainstem bronchi in a further 3 patients. None of the patients had evidence of atelectasis on the admitting chest X-rays, except for a right middle lobe collapse in patient #2. Previous extubation attempts had been unsuccessful in patients #1, #3 and #7. Only 1 of the 7 patients required a second procedure to establish airway patency (patient #4), having failed a trial of extubation after the first procedure. Generally, procedure-related complications were low. The only complications seen were stent associated mucus plugging in patient #1, which resolved after aerosol therapy and chest physiotherapy, and intraoperative hypotension secondary to dynamic hyperinflation in #4. No sequelae followed the hypotensive episode, which was reversed on re-establishment of airway patency. All 7 patients were successfully extubated within 2 days of the procedure and were successfully discharged from the hospital. Following extubation, 1 patient (#4) subsequently went on to receive external beam radiotherapy, and another (#6) received chemotherapy for small cell lung cancer. From the available records of the 5 patients with malignant tracheobronchial obstruction as of January 1999, survival ranged from 1½ months to an excess of 6 months.

Discussion

The ideal management of major airway stenosis remains unresolved. Unlike more distal stenosis, for example, lobar stenosis, which presents insidiously with distal atelectasis and post-obstruction suppuration, central airway obstruction is remarkable for its potential for an acute asphyxial event. Often, acute airway compromise occurs secondary to inflammatory swelling of the lesion, or post-stenotic retention of mucus and blood.

Respiratory failure from major airway obstruction is often multifactorial, which includes increased airway resistance, ventilation/perfusion mismatch, and secondary events from endobronchial bleeding and distal infection. Often, assisted ventilation is required to arbitrate sudden respiratory distress. The use of positive end expiratory pressure (PEEP) via an indwelling endotracheal tube provides excellent airway support against expiratory airway collapse from major airway malacia or extrinsic mass effect. Unfortunately, mechanical ventilation serves only

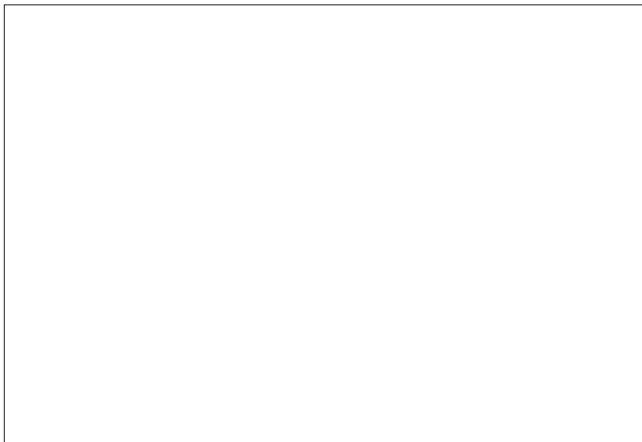


Fig. 1. Picture of DUMON stent.

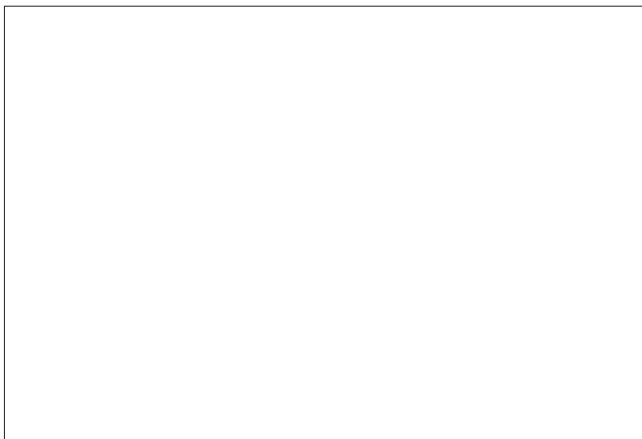


Fig. 2. Subglottic stenosis in patient #1 as viewed through the larynx.

TABLE I: PATIENT PROFILE, LEVEL AND NATURE OF OBSTRUCTION, ENDOBRONCHIAL THERAPY PERFORMED AND OUTCOME

Patient	Age (y)	Sex	Aetiology of stenosis	Histology	Site of stenosis	Length of stenosis (mm)	Procedure	Pre-procedural diameter (mm)	Post-procedural diameter (mm)	Ventilator days after stenting	Status following interventional bronchoscopy*
1	45	F	Post-tuberculous stricture	nil	Trachea: Complex subglottic	30	Balloon dilatation, laser, stenting	2-3	11	0	Alive at 29 months
2	40	F	Active tuberculous endobronchitis**	Granulomatous inflammation	Distal trachea, right main	60,10	Balloon dilatation and stenting	5,7	10	0	Returned to Philippines well 1 week later
3	80	F	Endoluminal tumour	Non-small cell carcinoma	Lower trachea, right main stem	20,10	Laser and stenting	7,3	14,11	1	Died 2½ months later
4	60	M	Extrinsic compression from adenopathy and mucosal infiltration	Adenocarcinoma	Distal trachea, right main, left main	30,10,30	Silicone stent insertion to distal trachea, subsequent Wallstent insertion (2 overlapping stents covering distal trachea and main bronchi)	6,6,pin-hole	16,14,12	1,1	Alive at 6 months
5	51	M	Oesophageal carcinoma with extrinsic tracheal compression	Squamous cell carcinoma	Mid-trachea	40	Stent insertion to trachea	3	14	0	Alive at 2 months
6	64	F	Extrinsic compression from adenopathy	Small cell carcinoma	Distal trachea	30	Stent insertion	2	11	1	Alive at 2 months
7	63	M	Endobronchial metastasis from colonic primary	Adenocarcinoma	Left main, right truncus intermedius	15,10	Forceps removal, stent insertion	8,2	14,6	2	Died 1½ months later

*Status as of March 1999. All patients were ambulant and discharged home post interventional bronchoscopy

** Progressive respiratory distress despite 4 weeks of anti-tuberculous treatment

as a temporalising measure, and patients with major airway obstruction pose significant obstacles to successful ventilator weaning.⁸ The earlier extubation failures noted in patients #1, #3, #4 and #7, prior to therapeutic bronchoscopy testify to the difficulties. Hence, successful restoration of airway calibre, with its effects on airflow, is a necessary prerequisite for successful extubation.

Our 2 patients with benign airway stenosis shared a common underlying aetiology, which was tuberculosis. Despite the high success rates in achieving microbiological sterility with anti-tuberculous chemotherapy, tuberculosis is known to leave permanent sequelae, among which is complex airway stenosis with malacia. Tuberculous endobronchitis, a precursor of subsequent endobronchial strictures, has been variously reported to occur in 10% to 36.8% of patients with parenchymal disease.⁹ Corticosteroid administration has had equivocal results in preventing subsequent stricture formation.^{10,11} Hence, there is presently no effective measure to prevent progressive airway injury and the patient is left with permanent disability despite successful medical therapy.

Malignant airway obstruction can be secondary to both endobronchial tumours and extrinsic compression from mediastinal tumours, or adenopathy. Tumours of the trachea or main bronchi may arise from primary bronchogenic carcinoma, or represent metastatic disease from thyroid, breast, kidney or colorectal neoplasms. There has been renewed interest in the management of malignant tracheobronchial obstruction. Previously, the mainstay for treatment of malignant airway obstruction has been external beam radiotherapy. This form of treatment is certainly far from ideal, with resolution of atelectasis in only approximately 23% of patients.¹² Chetty et al¹³ also demonstrated improvement in atelectasis in only 21% of their patients. Furthermore, the responders were also more likely to have received higher doses of radiation, and were also more likely to experience significant pulmonary complications from radiation therapy. More disconcerting were the results from a repeat bronchoscopy done on 14 patients with near total occlusion, which showed persistent endobronchial tumour in all 14 patients. In addition to the incomplete response, the delayed onset of clinical improvement also limits this form of therapy to ambulatory patients. Endoscopic therapy shows extremely promising results in restoration of central airway patency. Cryotherapy, electrocautery, brachytherapy, lasers and endobronchial stenting have been used to relieve malignant airway obstruction. The major advantage of endoscopic therapy with forceps resection, Nd:YAG laser application and stenting is the almost immediate improvement in respiratory symptoms with few complications.¹⁴⁻¹⁶ The choice of procedure varies with the nature of the stenosis. Forceps resection and Nd:YAG lasers would be primarily useful in

lesions with a large endobronchial component, while stenting would be more appropriate with extrinsic compression and localised tracheomalacia.^{5,6} With the above combination, most causes of major luminal obstructions would be amenable to endoscopic correction. In the best hands, endobronchial therapy, using combinations of lasers and stents, has reported successes of 92% to 97% in restoring central airway patency,¹⁵ clearly superior to the rates of re-aeration following external beam therapy. As airway resistance is inversely proportional to the fourth power of the radius, we would expect even minor changes in luminal diameter to have dramatic changes in airflow.¹⁷ Certainly, restoration of airway calibre by endoscopic therapy is associated with improvements in ventilation/perfusion scans, which further translates to improvements in arterial blood gases and clinical symptoms.¹⁸ Other options for malignant airway obstruction include brachytherapy. While brachytherapy is highly effective at restoring luminal patency in 50% to 90% of patients,¹⁹ its utility in critical stenosis is probably limited owing to the delayed onset of improvement, and potential for post-radiation airway oedema which may further compromise the airway.

Following endoscopic therapy, we were able to permanently liberate all 7 patients from the ventilator. While we tended to use DUMON silicone stents for all cases, patient #4 had extensive lower tracheal and carinal disease, where severe stenosis of the left main bronchus precluded adequate dilatation to deploy a silicone stent. We revised our choice of stents to the self-expanding metallic stents, which was more efficacious in this particular case.²⁰ The self-expanding metallic stents require minimal pre-deployment dilatation.

The fact that our most common site of stenosis was the trachea may have contributed to our overall success. Cavaliere et al¹⁶ found that patients with tracheal obstruction derived the most benefits from endoscopic therapy. Our overall goal was to quickly wean these patients off the ventilator to avoid ventilator-associated complications. While laser and stent placement allows rapid relief of critical airway obstruction, considerable endobronchial and extrabronchial tumour is left untreated, which limits the durability of the improvement. Our policy, therefore, was to prolong this improvement with the routine insertion of prosthetic stents in all patients following tumour debulking. These patients had terminal malignancies for which disease progression, both intrathoracic and extrathoracic, may preclude subsequent general anaesthesia. Even with this, reocclusion can be expected. Bolliger et al²¹ demonstrated a 75% reocclusion rate in stented airways at 2 months post procedure. Our primary aim, therefore, was to facilitate rapid extubation with endoscopic techniques, and offer, where feasible, adjuvant treatment modalities,

for example, brachytherapy or external beam radiotherapy, to control local disease, in order to lengthen the period to restenosis.

While complications of indwelling stents such as migration and mucus plugging were frequently described in other studies, this was not a problem in our patients. The only patient (#1) with a significant problem with mucostasis resolved with conservative measures and did not require stent removal. Significant intraoperative hypotension occurred in patient #4 secondary to dynamic hyperinflation of the lungs and respiratory acidosis that required parenteral bicarbonate infusion and resolved with restoration of airway calibre. Other major stent-related complications have limited the usefulness of prosthetic airway stents in other reported series. Wassermann et al²² reported bacterial colonisation of the prosthesis with recurrent bronchial infection necessitating stent exchange in 30% of their patients. Granulation tissue formation around the stents is a notable problem with prosthetic stents. These difficulties were not seen in our patients. However, our review is limited by our short follow-up period (2 to 19 months), our small patient pool, and the fact that we did not routinely re-bronchoscope asymptomatic patients at intervals following interventional bronchoscopy.

Prior to the era of endoscopic techniques for luminal obstruction, patients with lung cancer requiring mechanical ventilation faced an extremely grim and distressing outcome.²³ Encouraging outcomes have been reported on ventilated patients with major airway stenosis treated endoscopically.²⁴⁻²⁶ Although in benign lesions, this level of intervention is acceptable for lesions not amenable to surgery, not all will share the same sentiments with respect to ventilated patients with terminal malignancies. In the authors' opinion, endoscopic therapy provides for effective palliation of dyspnoea without the sedative effects of opioids, and facilitates extubation to allow further definitive treatment planning.

In conclusion, endobronchial therapy is useful in allowing for liberation from ventilator dependence. This form of therapy should be offered to patients with life-threatening dyspnoea who would otherwise have a reasonable quality of life.

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