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Controlling difficult airway by rigid bronchoscope—an old but effective method

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Abstract

Managing the airway of patients with critical tracheal stenosis remains a formidable challenge to surgeons and anesthiologists. Various methods for controlling the airway have been established to solve this problem. This study describes the critical tracheal stenosis is managed by dilating and coring technique under direct vision with a rigid bronchoscope. From 2001 to 2003, 34 patients (23 males/11 females) with critical tracheal stenosis (>90%) underwent 37 surgical interventions. The etiologies included 8 cases of post-intubation, 7 cases of post-tracheostomy, 5 cases of post-anastomotic, 14 cases of endotracheal tumor (4 primary, 10 secondary), and 3 cases (1 tuberculosis, 1 laser burn, and 1 idiopathic) of other etiologies. All procedures could achieve airway control with rigid bronchoscope. Other endoscopic procedures (laser, and stent placement) were required to achieve a patent airway and seven patients received airway reconstruction as a definite procedure. Rigid bronchoscopy could provide good results for controlling airway in patients with critical trachea stenosis.

Keywords: Critical tracheal stenosis; Rigid bronchoscopy; Difficult airway

1. Introduction

Central airway stenosis, a life- threatening problem, often requires emergent intervention. The modality includes: endoscopic management (core out, laser resection, and stent insertion), percutaneous dilation therapy, and open surgery procedures (airway widening, resection, and end to end anastomosis) [1–3].

The appropriate anesthesia and management of the central airway stenosis challenges both anesthesiologists and thoracic surgeons. Achieving a stable airway in this group of patients to facilitate airway reconstruction as well as bronchoscopic palliation are critical [1–3]. Various airway control methods were developed in search of optimal outcomes for this patient population and each has its own merits and limitations [4–7].

Rigid bronchoscopy is well known as the conventional means of implementing bronchotherapeutic procedures [2,3,8] but the role of rigid bronchoscope in controlling central airway stenosis was not widely employed by medical physicians. This investigation describes the feasibility of effectively managing critical airway by dilation and coring with rigid bronchoscope.

2. Materials and methods

From January 2002 to December 2003, 100 patients underwent bronchotherapeutic procedures at Chang Gung Memorial Hospital (a 3000-bed referral center). Thirty-four (23 males/11 females) of these had life threatening dyspnea due to large airway obstruction and required urgent intervention to relieve airway stenosis. The etiologies included 8 cases of post-intubation tracheal stenosis, 7 cases of post-tracheostomy tracheal stenosis, 5 cases of post-anastomotic stenosis, 14 cases of endotracheal tumor (4 primary, 10 secondary), and 3 cases (1 tuberculosis, 1 laser burn, and 1 idiopathic) of other etiologies. The lesions were all tracheal, and all patients had tracheal stenosis greater than 90%.

Pre-operative assessment of airway stenosis included flexible bronchoscopy, conventional CT scan with 2-D and 3-D reconstruction images, and virtual bronchoscopy. The percentage of obstructions was quantified visually and recorded as a percentage of the luminal area obstructed. Length of the stenosis was determined from the 3D reconstruction images, or alternatively, during surgical intervention

The whole procedure took place in the operation room. Basic monitoring included electrocardiography, oximetry and an arterial line. The tracheostomy tray was prepared and ready in the event of failure to control airway. The patient was placed in supine position and general anesthesia was achieved by short acting narcotics and opioid analgesic agents. After adequate sedation, the team introduced the rigid bronchoscope to assess the severity and location (distance from the vocal cords) of airway obstruction. Then, the beveled tip of Dumon scopes (Novatech; Aubagne, France) was introduced to manipulate, dilate the stenotic region. The stenotic segment was adequately dilat-

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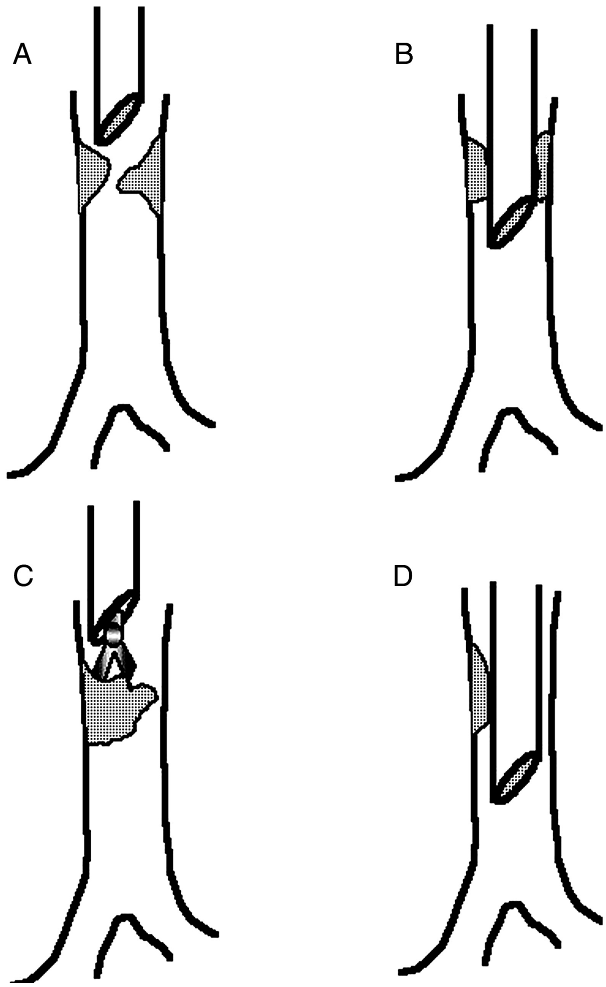

Fig. 1. Schematic representation the techniques: A,B: Dilation. C,D: Core out.

ed by the scope with an outer diameter of 8 mm or changing the scope from 8 mm to 14 mm stepwise. In cases of neoplastic obstruction, coring technique was applied to remove the tumor and achieve airway control (Fig. 1). The endotracheal tube was intubated down through the stenotic segment after therapeutic procedure and all patients were sent to the intensive care unit for further post-operative management. The outcomes were evaluated immediately after procedures and included: (1) successful and unsuccessful airway control; (2) complications related to operations. All parameters are summarized in Table 1.

2.1. Post-tracheostomy tracheal stenosis

Of the 7 patients, the stenotic length ranged from 10 to 32 mm, with a mean of 20 mm. The distance from the vocal cords measured 30 to 100 mm, with a mean of 60 mm. All stenotic airways were dilated and airway ventilation was successfully controlled with rigid bronchoscope. Three patients received airway stenting, two received stenotic tracheal resection and reconstructions, one received a long tracheostomy tube for airway stenosis, and one had stenotic segment dilation as definite procedure. The final respiratory performance was good in all patients.

2.2. Post-intubation tracheal stenosis

Of the 8 patients, the stenotic length ranged from 15 to 40 mm, with a mean of 24 mm. The distance from the vocal cord measured from 20 to 90 mm, with a mean of 47 mm. All stenotic airways were successfully controlled by rigid bronchoscope to enable the subsequent procedure for definite treatment. Two patients underwent subglottic laryngotracheal resection and anastomosis (Fig. 3), two received stenotic tracheal resection and primary anastomosis, two received silicone airway stent and one received a Montgomery T tube for stenting. Another patient underwent stenotic segment dilation as definite treatment. All patients survived with good respiratory and phonated functions.

2.3. Postanastomotic tracheal stenosis

The underlying disease included tracheal resection in two patients, laryngotracheal resection in two patients, and posttraumatic laryngotracheal separation in one patient. The average length of stenosis measured 19 mm (range 15–20 mm), with an average distance from the vocal cords of 25 mm (range 15–60 mm). The stenotic airway was palpated and dilated with rigid bronchoscope and providing airway control via introducing the scope through the stenotic airway. All patients underwent airway stenting with a Montgomery T tube.

2.4. Primary tracheal tumor

Four patients had tracheal stenosis due to primary tracheal tumor (one adenoid cystic carcinoma, one mucoepidermoid carcinoma, one spindle cell tumor, and one granular cell tumor). All but one lesion (lower trachea) was located at the upper trachea. All four patients underwent airway control via rigid bronchoscope and were treated by coring out the obstructing tumor with the rigid bronchoscope (Fig. 2). One patient had tracheal resection after tumor removal under rigid scope, while one patient received laser ablation after the coring out procedure. All these patients had stable airways and good surgical results.

2.5. Secondary tracheal tumors

Ten patients with secondary tracheal tumor had critical tracheal stenosis. The etiologies included four patients with esophageal cancer, three with lung cancer, one with mediastinal sarcoma, one with thyroid cancer, and one tongue cancer patient with mediastinal metastasis. The average length of stenosis measured 55 mm (range 15–110 mm). The distance from the vocal cords was from 30 to 100 mm, with a mean of 44 mm. Rigid bronchoscopy was used to explore, ventilate, and dilate airway obstruction for temporary control. Next, eight expandable metal stents and one silicone stent were used in 8 patients because of residual airway stenosis and extreme extrinsic tumor compression. One patient with mediastinal sarcoma required two stents to maintain airway patent (Fig. 4). All patients

Table 1
Patient characteristics and outcomes of procedures

Case No.	Age/Sex	Etiology	Stricture severity	Distance from vocal cord	Stricture length	Airway control	Final procedure
1	38/M	Tracheostomy	90	35	32	Yes	Airway reconstruction
2	46/F	Tracheostomy	90	35	25	Yes	Airway reconstruction
3	68/F	Tracheostomy	90	100	15	Yes	Airway stent
4	69/M	Tracheostomy	90	100	10	Yes	Airway stent
5	57/M	Tracheostomy	90	70	15	Yes	Airway stent
6	62/F	Tracheostomy	90	50	15	Yes	Long tracheostomy tube
7	55/M	Tracheostomy	90	30	15	Yes	Dilation
8	39/M	Intubation	90	45	20	Yes	Airway reconstruction
9	46/F	Intubation	90	30	30	Yes	Airway reconstruction
10	48/F	Intubation	90	30	25	Yes	Airway reconstruction
11	54/M	Intubation	90	20	30	Yes	Airway reconstruction
12	76/F	Intubation	90	50	20	Yes	Montgomery T-tube
13	78/F	Intubation	90	90	15	Yes	Airway stent
14	72/M	Intubation	90	80	15	Yes	Airway stent
15	52/M	Intubation	90	30	40	Yes	Dilation
16	18/M	Post-anastomotic	90	60	15	Yes	Montgomery T-tube
17	39/M	Post-anastomotic	90	20	20	Yes	Montgomery T-tube
18	46/F	Post-anastomotic	90	15	20	Yes	Montgomery T-tube
19	48/F	Post-anastomotic	90	15	20	Yes	Montgomery T-tube
20	58/F	Post-anastomotic	90	15	20	Yes	Montgomery T-tube
21	62/M	Primary tracheal tumor (Mucoepidermoid tumor)	80	80	15	Yes	Airway reconstruction
22	46/M	Primary tracheal tumor (Cystic adenoid carcinoma)	90	50	15	Yes	Core out
23	22/M	Primary tracheal tumor (Spindle cell)	90	30	15	Yes	Core out
24	45/M	Primary tracheal tumor	99	10	15	Yes	Core out
25	47/M	Esophageal cancer	90	80	40	Yes	Airway stent
26	52/M	Esophageal cancer	90	40	60	Yes	Airway stent
27	56/M	Esophageal cancer	90	20	50	Yes	Airway stent
28	59/M	Esophageal cancer	90	10	50	Yes	Airway stent
29	63/M	Lung cancer with trachea meta	90	50	20	Yes	Core out
30	71/M	Lung cancer with trachea meta	90	40	15	Yes	Core out
31	78/M	Lung cancer with trachea meta	80	10	30	Yes	Airway stent
32	68/M	Tongue cancer with trachea meta	90	80	30	Yes	Airway stent
33	56/F	Thyroid cancer with trachea meta	90	20	25	Yes	Airway stent
34	16/M	Sarcoma with mediastinal involvement	99	40	110	Yes	Airway stent
35	49/F	Tracheal stricture	99	20	25	Yes	Tracheostomy
36	32/M	Laser burn	99	10	10	Yes	Tracheostomy
37	68/M	TB stricture	90	15	90	Yes	Airway stent

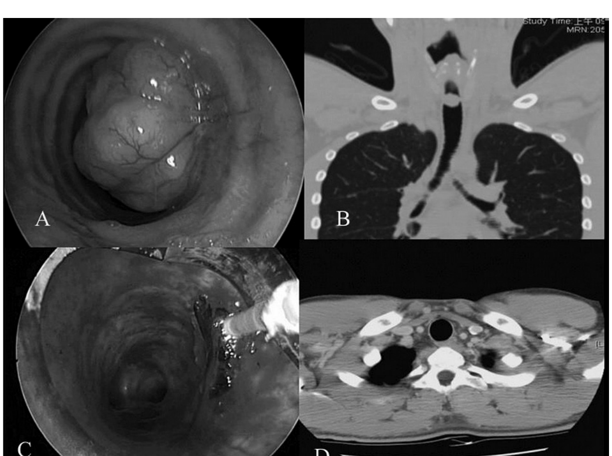

Fig. 2. Endoluminal tumor (cystic adenoid carcinoma) with severe tracheal stenosis: A,B. Preoperative bronchscopy and CT finding. C. Intraoperative bronchoscopic finding after coring out procedure. D. Postoperative CT image.

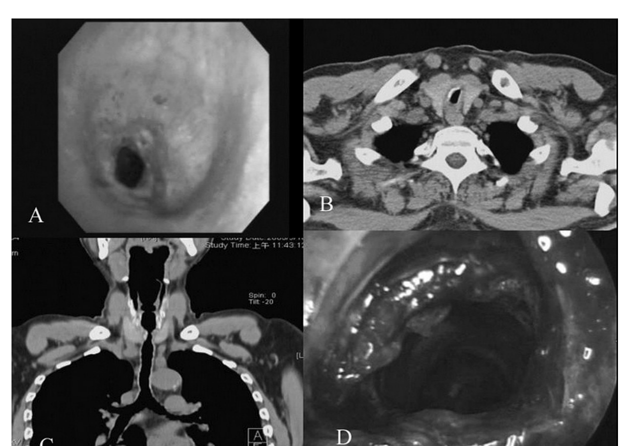

Fig. 3. Post-intubation tracheal stenosis: A,B,C: Bronchoscopic and CT finding before intervention. D. Bronchoscopic finding after rigid bronchoscopic dilation.

Fig. 4. Mediastinal sarcoma with tracheal compression: A,B,C: Preop CT scan revealed severe airway compression by tumor. D. CXR after airway stenting.

had good airway control during the operation and adequate palliation of respiratory symptoms with rigid bronchoscopy.

2.6. Miscellaneous

The underlying diseases were: tuberculous airway stenosis in one case, airway stenosis due to laser surgery in another and stenosis with unknown origin in a third. Rigid bronchoscope was used to assess and dilate the stricture and provide a controlled situation for adequate ventilation and definite procedures in all patients. Therapeutic procedures included incorporated Hood and T stent in one patient and tracheostomy tube in two others. However, one patient with airway stenosis (origin unknown) receiving tracheostomy died with acute airway obstruction 5 days after surgery.

2.7. Complications

All stenotic airways were successfully dilated, cored out and intubated with the rigid bronchoscope and provided safe and well-ventilated environments for definite airway procedures. There was no immediate mortality due to loss of control airway. One airway perforation (esophageal cancer with lower trachea and carina invasion) occurred during stenting and the patient died five days after the operation. The second patient with long segment airway stenosis of unknown origin from glottic to main bronchus died five days postoperatively.

3. Discussions

Tracheal stenosis continues to be largely owing to trauma, which can be internal (prolonged endotracheal intubation, tracheotomy, flame burn injury) or external (blunt or penetrating neck trauma). The symptoms of central airway stenosis are distressing. Therapeutic strategies for these patients include surgical resection combined with appropriate reconstruction and interventional bronchoscopic procedures (dilation, laser ablation, and tracheobronchial stent).

Achieving good results and preventing perioperative complications in these patients depends on the ability to provide a safe and good ventilating environment before surgical intervention. Among the many anesthesia strategies developed for critical airway management include fiberoptic intubation, laryngeal mask airway, high frequency jet ventilation, total laryngeal bypass device, tracheostomy under local anesthesia, and cardiopulmonary bypass. However, these strategies have their merits and limitations.

Anesthesiologist commonly used fiber-optic intubation with difficult airway. Benum presented a method of initial fiberoptic intubation above the lesion followed by second intubation distal to the lesion after surgical opening of the trachea [15]. In 1999, Mentzelopoulos presented a method combing the use of a Fogarty catheter with fiberoptic bronchoscope and endotracheal tube to intubate the stenotic airway [5]. But there are some limitations in cases with severe stenosis. Because the risk of inadequate ventilation caused by the severity of the stenosis would be present until successful second intubation.

Laryngeal mask airway (LMA) is another effective method for maintaining airway and obtaining an operating field for endoscopic procedures. Parmet JL encouraged LMA insertion as the first alternative in patients with unanticipated simultaneous difficulty with mask ventilation and tracheal intubation [14]. However, for practicability an LMA is not comparable with a rigid bronchoscopy. Because LMA would be applicable only to simple endoscopic procedures, the efficiency and safety of airway control with rigid bronchoscopy is still best for dealing with intra-operative complications of bleeding and tumor extraction [3,8].

High frequency jet ventilation (HFJV) is a conventional method for securing ventilation in rigid and interventional bronchoscopy [6,10,11]. However, this is dangerous in critical laryngeal stenosis (<4.5 mm) because outflow from the lungs may be inadequate. Dworkin first reported that air trapping can occur during jet ventilation if the airway diameter proximal to the tracheal catheter tip is smaller than 4.0 mm [12]. Benum reported the hazard of inadequate outflow causing hypotension and barotraumas to the lungs unless jetting is stopped and an outflow pathway is immediately established [13].

Owing to the risk of jetting ventilation, a new device, total laryngeal bypass device (TLBD), was introduced since 1998 [4]. It is a new device which permits safe ventilation of these patients without tracheotomy. It is based on a coaxial bicannular design that allows ‘push-pull’ ventilation by jetting gas through the inner cannula and applying suction through the outer cannula. This ideal design could provide actively expiration of gas compared with old jetting device. However, it is not available everywhere.

Cardiopulmonary bypass (CPB) and extracorporeal membrane oxygenation (ECMO) are commonly performed techniques in cardiac surgery. They can be applied either where bulky airway lesion precludes safe ventilation via conventional methods or in the presence of low pulmonary function and respiratory failure. Many authors find CPB and ECMO extremely useful for achieving good cardiopulmonary support during severe tracheal stenosis and in placing airway stents [16,17]. However, due to the serious complications after CPB [18–20], neither technique was used in the current series.

Thus, tracheotomy under local anesthesia was considered as the safest method of ventilation by many authors [4,5]. However, it is challenging when faced with an uncooperative patient, a difficult airway and indistinct anatomical landmark.

Rigid bronchoscope has several advantages, including simultaneous dilate and visualize the stenotic part. Ventilation could also be maintained via side port and minimize the risk of inadequate ventilation before controlling airway. It is not so invasive as tracheostomy or cardiopulmonary bypass, less risk of barotraumas than jetting device, low equipment demand compared with TLBD [2]. In our experience, starting with an 8 mm Dumon bronchoscope followed by serial dilating the stenotic part or coring the obstructing tumor could achieve safe airway control in all cases. The bronchoscope is introduced through the stenosis with a firm but gentle, slightly rotary movement, the axis of the airway must be kept in mind to avoid penetrating the trachea wall. Minimal biopsy can test vascularity if there is concern. Some authors recommended the use of laser in order to achieve better hemostasis. In our series, bleeding is not often a problem after core out, which could be controlled by direct bronchoscopic pressure.

4. Conclusions

Rigid bronchoscopy is a simple and safe method for airway control in patients with critical trachea stenosis.

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