Treatment of Atelectasis with Selective Bronchial Suctioning*

Use of a Curved-Tipped Catheter with a Guide Mark

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We applied our technique of selective bronchial suctioning (SBS) for the treatment of atelectasis (AT) of middle and lower lobes; nine patients with refractory ATs were successfully treated. We considered that SBS using a curve-tipped catheter with a guide mark (CTCGM) is the technique of choice for the treatment of refractory AT when conventional respiratory therapy is not effective and a bronchoscopist is not available. (Chest 1991; 99:510-12)

AT = atelectasis; SBS = selective bronchial suctioning; CTCGM = curve-tipped catheter with guide mark; STC = straight catheter

Atelectasis (AT) secondary to retained secretions is a common occurrence in postoperative and critically ill patients. Recently, fiberoptic bronchoscopy (FOB) has been used extensively in treatment, but a bronchoscopist may not always be available when FOB is necessary. Thus, we have developed a technique for selective bronchial suctioning (SBS) using a curve-tipped catheter with guide mark (CTCGM) and have successfully treated refractory AT of the middle or lower lobes by this technique. We describe our technique and report its use.

METHODS

All patients who underwent major surgery received general anesthesia with an appropriate cuffed endotracheal tube (ET). Immediately after intubation, we performed unilateral bronchial intubation to evaluate the distance from upper incisor teeth or alveolar ridge to the carina, also carina to right upper lobe bronchus by means of auscultation. The tip of the ET was situated 3 to 5 cm above the carina to allow for the length of the curved tip of the suction catheter (about 2.5 cm) depending on body height. The distance from the tip of the ET to the carina by auscultation agreed with measured roentgenographic distances. All measurements were recorded on the anesthesia chart. Postoperatively, endotracheal intubation was performed with the aid of intravenous diazepam whenever required for SBS.

For suctioning of the middle or lower lobes, the tip of the CTCGM is directed toward the objective bronchus and the guide mark of

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the catheter faced to that side as the catheter is advanced, until resistance is encountered after passing the carina. Subsequently, suctioning is performed over 1 to 2 s, the catheter is withdrawn to 5 cm, and an attempt is then made to direct the catheter tip successively anteriorly, posteriorly, and medially with suctioning performed in the ipsilateral bronchus at each point as quickly as possible.

In addition to the above, another important factor in successful SBS is the position of the tip of the ET in relation to the tracheal wall, i.e., the bevel of the tube is placed at the center of the trachea ad should not be deviated to either side as previously described. Otherwise, the catheter cannot be correctly manipulated. Therefore, the patient’s head should be placed in midposition, the tube should be fixed at the center of the mouth, and an appropriate sized ET should be chosen to prevent deviation of the tip within the trachea.

CASE REPORTS

CASE 1

A 79-year-old woman underwent total gastrectomy and left ovariectomy for cancer of the stomach and a left ovarian cyst under general endotracheal anesthesia (Portex ID 8 mm, distance from incisor teeth to carina 25 cm, tube fixed at 20 cm). On the second postoperative day, massive AT of the left lung developed. A thoracic surgeon performed bronchoscopy and aspirated mucous secretions. After treatment, however, the chest roentgenogram revealed residual AT of the left lower lobe, while breath sounds over that area were inaudible. The trachea was intubated with a cuffed ET (Portex ID 8mm). Several SBS/CTCGM (Portex 14FG) were performed and mucous secretions were aspirated. Breath sounds became audible and the chest roentgenogram revealed marked improvement in aeration. Thereafter, the postoperative course was uneventful.

CASE 2

A 61-year-old man underwent total gastrectomy for cancer of the stomach under general endotracheal anesthesia (Portex ID 9.5 mm, distance from incisor teeth to carina 27 cm, tube fixed at 23 cm). On the third postoperative day, lobar AT of the right lower lobe developed, not corrected by vigorous external compression of the trachea and transcricothyroid injection of saline solution. Therefore, 7.5 mg of diazepam was given intravenously and the trachea was intubated with a cuffed ET (Portex ID 9 mm) fixed at 24 cm. SBS/CTCGM were performed with aspiration of copious secretions. The chest roentgenogram then revealed reaeration of the right lower lobe.

DISCUSSION

The majority of instances of AT can be treated by conventional physiotherapy or endotracheal suctioning using a straight catheter (STC). When AT cannot thereby be corrected, FOB has been used. To our knowledge, other than our series of patients, there are no previous reports concerning successful treatment of AT using only a suction catheter. Textbooks on respiratory therapy do not describe or recommend treatment of AT using a suction catheter and imply that a suction catheter can only reach the level of the main-stem bronchi.

Further, they usually cite difficulty in left bronchial catheterization using an STC, and they do not recommend advancement of the catheter beyond the main-stem bronchi. These tenets have been accepted by many physicians and respiratory therapists ever since a urethral-type catheter was used for suctioning. Endobronchial suctioning could not be accomplished owing to the minimal length of the urethral catheter. Thus, endotracheal suctioning rather than endobronchial suctioning is performed today by most operators.

The results of our roentgenographic study on more than several hundred patients indicated that the tip of the catheter can indeed reach the level of the diaphragm, while the tip of an ordinary FOB cannot. Tenacious mucous plugs cannot be aspirated unless the tip of the catheter or FOB attains that depth as reported in case 1. Left bronchial catheterization can be performed with a success rate of 97 percent using a CTCGM.3

It has been shown that mucosal trauma related to tracheobronchial suctioning is more likely the result of repeated attempts, use of force, and degree of suction applied, regardless of type of catheter used.4 Our earlier study indicated that the STC entered the right bronchus successfully in 79 percent of patients owing to the anatomy of bifurcation.3 Thus, there is a greater chance of damaging mucosal membranes of the right bronchus than the left. We have witnessed perforation of the right main-stem bronchus owing to suction with STC in a tracheostomized patient with myasthenia gravis. We have performed SBS on more than several thousand patients without major untoward effects. When CTCGM is not available, one can easily be constructed using a cigarette lighter and a guide mark is placed using a felt-tipped pen. Teaching SBS/CTCGM can be done using a tracheobronchial model. In patients, determination of the location of the tip of the catheter can be performed by either chest roentgenogram or our sound signal device.6 When our device is not available, alternatively, an audible sound generator can be used.

Fiberoptic bronchoscopy can be performed without an ET in place, but our method is not applicable in that circumstance. However, when an ET is in place, the lungs can be ventilated while both FOB and SBS are being performed; this is a safer approach, especially when procedures are prolonged. Various audits of bronchoscopic practice have reported mortality rates of 0.01 to 0.5 percent and major complication rates of 0.06 to 5 percent.7 We have not encountered a death or major complication associated with bronchial suctioning over the past 27 years. In addition, with an ET in place, humidification of thick mucous secretions can be done more effectively and inflation of the lung can be more easily accomplished after removal of mucous secretions.

Recently, Sen and Walsh8 suspected that unneeded FOB is most likely to occur in overzealous therapy for AT. It has been demonstrated that no significant difference exists in restoration of postoperative volume loss between bronchoscopy and chest physical therapy.8 We have never used FOB for the treatment of AT in the past ten years.

We found that the tip of CTCGM could not be inserted into the bronchus of the right upper lobe and we had difficulty in inserting it into the left upper lobe owing to the anatomy of bronchi of upper lobes. Therefore, our technique is not applicable to AT in those areas. We developed the technique and successfully treated ATs of the right upper lobe.20

In conclusion, the results of the present report indicate that SBS/CTCGM is the method of choice for the treatment of AT of middle and lower lobes when conventional respiratory therapy is not effective and a bronchoscopist is not available.
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REFERENCES

Monitoring the Effect of CPAP on Left Ventricular Function Using Continuous Mixed-Blood Saturation*

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The hypothetic benefit of CPAP on cardiac performance and on a reduction in VO_2 was tested in a patient before heart transplantation after acute myocardial infarction using continuous SV_O2 monitoring. The CPAP added to isotropic support (enoximine plus dobutamine) and intra-aortic balloon pumping dramatically increased SV_O2 in relation to both an increase in cardiac output and a decrease in VO_2 secondary to respiratory work reduction, validating the initial hypotheses.

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SAP = systemic arterial pressure; SV = stroke volume; 
Ppa = pulmonary arterial pressure; Pao2 = pulmonary arterial occlusive pressure; SV_O2 = mixed-venous oxygen saturation; PrA = right atrial pressure; RR = respiratory rate; IAoBC = intra-aortic balloon counterpulsulation; D = dobutamine; E = enoximine; TV_aO2 = oxygen delivery

Increased intrathoracic pressure by the application of CPAP or a Valsalva maneuver improves LV performance in patients with decreased cardiac contractility, presumably by reducing LV afterload secondary to the decrease in transmural LV pressure. If this LV functional improvement increases cardiac output, then it may be associated with an increase in peripheral oxygen supply and a better oxygen supply-demand ratio, which in a patient with unchanging oxygen demand (VO_2) will result in an increase in SV_O2. A CPAP-associated increase in SV_O2 might also result from a reduction in oxygen demand owing to a reduced work cost of breathing. Since respiratory muscle oxygen requirements can account for a considerable proportion of total VO_2 during heart failure, a reduction in respiratory work load may also be beneficial in allowing greater oxygen availability to other tissues. This hypothesis has not been demonstrated in man during spontaneous breathing through a CPAP circuit.

Using continuous monitoring of SV_O2, we observed a patient in whom this hypothesis appears to have been validated.

CASE REPORT

A 55-year-old woman was admitted to the cardiology intensive care unit after sustaining a posterior myocardial infarction. Significant hemodynamic deterioration despite maximal therapy led to the decision to perform a heart transplantation on the patient. On admission the patient had a blood pressure of 72/46 mm Hg with 15 percent LV ejection fraction with diffuse kinetic abnormalities by two-dimensional echocardiography, indirect signs of low cardiac output, including decreased urinary output, and mitral insufficiency documented by pulsed Doppler echocardiography. Pulmonary arterial catheterization with a balloon-directed fiberoptic catheter (Oximetrix 3) and a radial arterial catheterization were instituted. Systemic arterial pressure (in millimeters of mercury), cardiac output (in liters per minute by thermodilution), SV (in milliliters per beat), Ppa, Pao2, PrA, and SV_O2 were measured. Heart rate (in beats per minute) and RR (in cycles per minute) were also monitored. Systemic and mixed-venous blood gas levels and hemoglobin saturations were also measured, allowing calculation of complete hemodynamic profiles.

The resuscitative therapy included sequentially and in an additive fashion: continuous infusion of D (18 mg/kg/min), IAoBC, a bolus infusion of E, and, because of the persistence in arterial hypoxia, tachypnea, and symptoms of heart failure, CPAP by mask with a pressure of 7 cm H_2O, with pressure support of 5 cm H_2O to reduce the respiratory work.

Table 1 shows hemodynamic and metabolic data during (1) D, (2) D plus IAoBC, (3) D plus IAoBC plus E, and (4) D plus IAoBC plus CPAP. The SV_O2 increased only after CPAP from 38 percent to 67 percent (Fig 1, arrow 1), with proportional increases in SV, cardiac output, and CaO_2 and decreases in RR, VO_2, and (a-v)O_2. The increase in SV_O2 was rapid, reaching a new equilibrium in two minutes (Fig 1). Clinically, the patient felt much better and asked for the CPAP mask not to be removed. Figure 1 shows that when CPAP was transiently removed for nursing purposes (arrow 2), SV_O2 rapidly fell, returning to the newly elevated level once CPAP was reinstituted. Interestingly, neither oxygen transport nor VO_2 was related to the conditions studied. Figure 2 shows the relation...