Rapid Intravenous Induction of Anesthesia for Dilatation of Severe Post-Intubation Tracheal Stenosis with Rigid Bronchoscopy: Report of 100 Cases

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Abstract: ***Background*:** Rigid bronchoscopic dilatation is the lifesaving method for management of severe tracheal stenosis which is carried out under general anesthesia. However, this procedure is a challenging practice for both anesthesiologist and bronchoscopist because loss of airway control and sever hypoxemia can occur following induction of anesthesia. Inhalational induction with avoiding muscle relaxants and preservation of spontaneous breathing is commonly recommended in these patients. However, this technique needs a long time to reach the appropriate levels of anesthesia and may be associated with the risk of complete airway obstruction during airway manipulation. This paper describes our experience in using rapid intravenous induction of anesthesia for dilation of severe tracheal stenosis with rigid bronchoscopy.

***Materials and Methods*:** We conducted a retrospective chart review of one hundred patients with benign severe post intubation tracheal stenosis who underwent rigid bronchoscopy for dilation of stenosis using intravenous sodium thiopental and succinylcholine for induction of general anesthesia.

***Results*:** In 97 patients adequate airway was established immediately after induction of anesthesia with the first attempt of rigid bronchoscope. In one patient, because of local bleeding and mild hypoxemia the airway was managed by a 4 mm tracheal tube and following improvement of oxygenation, dilatation of stricture was successfully done with rigid bronchoscope. In second patient, after passing the first bronchoscope, due to risk of rupturing the trachea, a small transverse cervical incision was made on the trachea and a tracheal tube was inserted through it for patient's ventilation and dilatation of stricture was managed safely with the rigid bronchoscopes. In the third patient, due to failure of passing the bronchoscope, the trachea was intubated with a 4 mm endotracheal tube and tracheal resection and anastomosis was done successfully.

***Conclusion*:** in patients with severe post intubation tracheal stenosis, rapid intravenous induction of anesthesia is a safe method for passage of rigid bronchoscope for dilatation of stricture. Careful planning and close cooperation of the anesthesia and surgical teams is critical for safe and successful conduction of this procedure.

Keywords: Tracheal stenosis, Anesthesia, Bronchoscopy, Dilatation.

1. INTRODUCTION

Laryngeal and tracheal stenoses are among the complications of prolonged tracheal intubation. During the past years, we encountered many of these patients who were under ventilatory support due to accidents, surgical procedures, or various diseases for some time and subsequently developed post-intubation airway stenosis [1]. In cases with severe and critical airway stenosis (airway diameter smaller than 5mm) immediate dilatation of the stricture with rigid bronchoscopy is the main lifesaving treatment approach to resolve airway obstruction. This procedure is carried out under general anesthesia and if not properly performed, it can lead to severe hypoxemia and loss of airway before attempting the dilation [2, 3]. Airway management in these patients is a serious challenge for the anesthesiologist and the bronchoscopist because they are dealing with an abnormally narrowed airway that they have to share and may suddenly get out of control. They have to provide adequate oxygenation and ventilation of patient through this airway and at the same time achieve adequate depth of anesthesia for insertion of bronchoscope into the glottis and trachea. There is always a risk that anesthesia induction and airway manipulation in these patients lead to complete airway obstruction before attempting the dilatation.

There is no specific guideline for airway management in patients with severe tracheal stenosis. Although these patients fall into the category of "difficult airway", the airway management approach taken by the American Society of Anesthesiologists is not very helpful when encountering this condition [4]. In our opinion, selection of the anesthetic technique should be based on the expertise of the anesthesiologist and the

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bronchoscopist in maintaining an airway and they can adopt a specific technique based on factors such as patient's condition, their practical experience, and severity and the location of the stricture [5-8]. Inhalation anesthesia induction along with preservation of spontaneous breathing and avoiding muscle relaxants has been suggested as the safest method in these patients [9, 10]. However, this technique has some disadvantages as well; for example, it requires patient's cooperation, it takes a long time until adequate depth of anesthesia is reached, it can cause respiratory acidosis, it is associated with the risk of airway irritability, cough, spasm and even complete obstruction of airway during anesthesia induction and airway manipulation, it takes a long time until the patient recovers from anesthesia and last but not least, leakage of inhalation anesthetics is irritating [11-14]. On the other hand, anesthesia induction and muscle relaxation with short-acting intravenous drugs is a quick method to achieve adequate depth of anesthesia and pass the rigid bronchoscope beyond the level of stricture. This method also prevents the spread of anesthetic gases into the operating room and accelerates the recovery of patients from anesthesia [15]. This study describes our experience in using rapid intravenous induction of anesthesia for dilatation of severe post-intubation tracheal stenosis with rigid bronchoscopy.

2. MATERIALS AND METHODS

This study was approved by the Ethics Committee of our hospital. In this descriptive cross-sectional study, clinical records of patients with benign severe critical post-intubation tracheal or laryngo-tracheal stenosis who underwent rigid bronchoscopy for dilation of stenotic site with rapid intravenous anesthesia induction were evaluated. The airway stenosis was diagnosed by thoracic surgeons based on a previous history of airway stenosis or prolonged tracheal intubation or tracheostomy along with clinical presentation of upper airway obstruction. Patients were selected using non-probability convenience sampling. Patients with dyspnea, severe inspiratory and expiratory stridor at rest, suprasternal retraction, restlessness due to difficulty breathing and with no tracheostomy or T tube who had undergone bronchoscopy by a thoracic surgeon and anesthesiologist with over 5 years of experience in this field were included in the study. Patients who on clinical examination had one or more of the difficult airway criteria for tracheal intubation (history of difficult intubation, limitation in mouth opening, limitation of extension or flexion of head and neck, thyromental distance <5cm, and kyphosis) were excluded from the study.

Patients did not receive any premedication. In the operating room, oxygenation was established through nasal cannula and standard monitoring including pulse oximetry, electrocardiogram and non-invasive blood pressure measurements were carried out; 8 mg dexamethasone was administered intravenously. Rigid bronchoscopy instruments, tracheal tubes, laryngeal masks of different sizes and tracheostomy set were prepared; 1 mg/kg lidocaine, 50-100 µg fentanyl and 1-2 mg midazolam were administered. Patients were preoxygenated with 100% oxygen for 3 to 5 minutes using anesthesia mask. Sodium thiopental (5 mg/kg) was then injected. After ensuring the feasibility of lung ventilation with the mask, succinylcholine (1-1.5 mg/kg) was administered for muscle relaxation and the positive-pressure ventilation was delivered through the mask. After ensuring adequate oxygenation, patient's ventilation was discontinued momentarily so that the surgeon could observe the epiglottis and the glottis through the laryngoscope. Using zero degree telescope, the surgeon evaluated the larynx and subglottic region in a glance, located the stricture and estimated its severity. Next, the surgeon introduced a number 3 or 4 bronchoscope into the glottis. The bronchoscope was passed beyond the level of stricture without much pressure and established patient's airway and ventilation. After ensuring adequate oxygenation, atracurium was injected for continuation of muscle relaxation, if required and anesthesia was maintained by propofol infusion. The bronchoscope was then extracted and dilatation of the stenotic site was continued by consecutive insertion of larger tubes into the trachea. During this procedure, the patients were ventilated with 100% oxygen through the bronchoscope. After completion of the procedure until resumption of spontaneous breathing, the patients were either ventilated by anesthesia mask or with a proper size cuffed tracheal tube and if possible, they were extubated in the operating room. Data regarding patients, the procedure, airway stenosis characteristics and complications were recorded. Data were analyzed using SPSS software and descriptive statistical tests.

3. RESULTS

A total of 100 patients were enrolled. Out of which 24 were females and 76 were males with a mean age of 31.5±17.5 yrs. (range 1 to 82 yrs.) and a mean weight of 67.47± 13.60 kg (range 35-105 kg). The mean duration of previous tracheal intubation was

15.30±11.86 days (range 3 to 90 days). A total of 47 patients had a history of tracheostomy, 4 had a history of tracheal resection and anastomosis and 1 had a history of airway laser therapy. Causes of tracheal intubation and location of stenosis are demonstrated in Table **1**. The mean length of stenosis was 29.28±7.77 mm (15-50 mm). The mean duration of anesthesia (from the onset of anesthesia induction to recovery from anesthesia and extubation) was 38.12±16.12 min.

Table 1: Causes of Prolonged Intubation and Location of Airway Stricture

	No. of Patients
Causes of intubation	
Trauma	**69**
Suicide	**13**
Surgery	**10**
Others	**8**
location of stricture	
Subglottic	**15**
Mid-trachea	**67**
Laryngo-tracheal	**18**

In 97 patients adequate airway was established immediately after anesthesia induction with the first attempt of rigid bronchoscope. The stenosis was then successfully dilated and signs of severe obstruction were resolved. In 3 patients, some problems were encountered during the procedure but the airway was eventually managed and no adverse complication occurred: in one patient, local bleeding impaired the vision when passing the bronchoscope beyond the level of the stenotic site and the patient suffered transient hypoxemia (SPO2<85% for less than 1 minute); but since the stenotic site had been previously located using telescopic vision (at the first tracheal ring) we successfully managed the airway by passing a #4 uncuffed tracheal tube through the site. After improvement of oxygenation, tracheal tube was extracted and dilatation of stricture was done with rigid bronchoscope. The patient was discharged ambulatory. In another patient, after passing the first bronchoscope we noticed the spiral path of stricture and were concerned about rupturing the trachea. Thus, under the direct vision of rigid bronchoscope and ventilation of patient through it, the cervical trachea was exposed by a small transverse cervical incision made between the first and second tracheal rings. A tracheal tube was inserted into the trachea through this incision and patient's ventilation was established through it. Afterwards, dilatation of stricture was performed by rigid bronchoscopes. A tracheal tube was then introduced into the trachea through the mouth and the incision on the trachea was repaired. The anesthetic and surgical course was uneventful. The patient was extubated in the operating room and discharged from the hospital 4 hours later. In our third patient, the anatomy of the mouth and jaws prevented the passage of rigid bronchoscope but the surgeon was able to insert the telescope through the corner of the mouth in a bent angle and estimate the tracheal diameter at the stricture site (upper one-third of the trachea between rings 3 to 5). The patient was intubated using a #4 uncuffed endotracheal tube and ventilation was established. Vital signs and oxygenation were stable throughout the procedure. The patient underwent resection and anastomosis of the stenotic site in the same session which went well and the patient was extubated in the operating room. All patients were transferred to the recovery room and discharged after resolution of airway obstruction symptoms.

4. DISCUSSION

We were able to successfully manage the critical procedure from the time of anesthesia induction to establishing a safe airway and none of our patients developed spasm, airway obstruction or related complications. As observed in our study, close cooperation of the anesthesiologist and the surgeon is necessary for a successful outcome, prevention of laryngeal and tracheal injury and its fatal consequences. The anesthesia and surgical team should have a specific plan and also a plan B for management of airway before starting the procedure and should be able to foresee the potential complications and have the required ability to quickly establish the airway and preserve oxygenation of patient. Therefore, although in 3 patients rigid bronchoscopy encountered a problem after anesthesia induction, we successfully maintained the airway and oxygenation of patient with no adverse complication.

As a general principle, when a patient presents with stridor and tachypnea, it means that the tracheal diameter has been narrowed by at least 50%. When a patient has dyspnea and severe respiratory distress at rest, tracheal stenosis has usually reached a critical threshold of 75% or more. In such cases, airway

management is very difficult for the anesthesiologist and the surgeon [16]. Patients with severe tracheal stenosis are at constant risk of severe hypoxemia and choking and airway manipulation or administration of hypnotic or anesthetic drugs can accelerate or aggravate this condition. No sedatives should be administered for patients before preparing the abovementioned instruments. Also, the surgeon who performs the procedure should be familiar with the techniques of the resection of the stenotic site.

Various methods are used for anesthesia induction and establishing ventilation in these patients [11, 16-19]. The main principle is that the technique of procedure should be selected based on the experience and expertise of the anesthesia and surgical teams, patient's status and stenosis characteristics. The most common method of anesthesia induction is inhalation without using muscle relaxants because this way we can maintain patient's spontaneous breathing and decrease the risk of losing the airway [3, 7, 10, 20-22]. Hakumoto *et al*. induced anesthesia by using propofol and sevoflurane in a patient with tracheal stenosis and after ensuring patient's proper ventilation with the mask, they injected the muscle relaxant [23]. Similarly, Li *et al*. used sevoflurane inhalation for anesthesia induction [19]. Mentzelopoulos *et al*. also used the same method for anesthesia induction in a patient with severe tracheal stenosis [22]. But the problem is in such patients, adequate depth of anesthesia takes a long time to achieve *via* inhalation anesthesia due to tracheal stenosis; thus, the excitatory phase in the course of anesthesia lasts longer. Also, if bronchoscopy is attempted before reaching adequate depth of anesthesia, airway reflexes such as coughing are aggravated and the patient is exposed to the risk of spasm, complete airway obstruction and related adverse complications. On the other hand, after completion of bronchoscopy, patient's recovery from anesthesia and reaching consciousness requires a significant amount of time [7, 20]. Some others prefer anesthesia induction with IV drugs for these patients and avoid using muscle relaxants until establishing a safe airway. Natalini *et al*. induced anesthesia with propofol and fentanyl without muscle relaxant [17]. However, airway dilatation in an unrelaxed patient is neither easy nor safe. Conacher *et al*. believe that the most reliable method of establishing a safe airway in tracheal stenosis patients is the ventilation of lungs with jet ventilation through rigid bronchoscopy under complete IV anesthesia with muscle relaxation; inhalation anesthesia or local anesthesia should not be used [24]. In accordance with their findings, Juvekar *et al*. concluded that this method is the safest way for tracheal dilation and stenting [7]. However, many medical centers do not have equipment required for jet ventilation. Our discussed method was rapid induction of anesthesia with the use of a short-acting IV drug and muscle relaxation with succinylcholine before any airway manipulation. In this method, risk of airway irritation and spasm is reduced and the lungs can be ventilated *via* the rigid bronchoscope. Some reports also regarding the use of laryngeal mask, suction catheter or nasogastric tube have been published for ventilation of patients with tracheal stenosis [18].

Furthermore, obtaining an airway in a patient with severe tracheal stenosis who has the criteria of difficult airway is among the biggest challenges of anesthesiologists and bronchoscopists. In our experience, in such cases, muscle relaxants should be avoided because mask ventilation may be unsuccessful, laryngoscopy may not be feasible or obtaining an airway with a rigid bronchoscope may go wrong [6, 25, 26]. In our study, due to mouth opening limitation in one patient, insertion of the rigid bronchoscope into the trachea was not possible and after difficult intubation with a small tube, we attempted the resection and anastomosis of the stenotic site in the same session to obviate the need for subsequent bronchoscopy and intubations. In tracheal stenosis cases with prior diagnosis of difficult airway, upon patient's consent and cooperation, we may anesthetize the nasopharynx and larynx with lidocaine and first perform fiberoptic bronchoscopy to assess the location and severity of stricture without passing the bronchoscope beyond the stenotic site and then perform temporary tracheostomy under local anesthesia. Tracheal resection and anastomosis should be attempted in the same session as well. However, it should be noted that presence of stridor at rest usually indicates narrowing of the airway by 60-70% [5]. Therefore, these patients may be anxious and agitated and may not be able to tolerate fiberoptic bronchoscopy. In such cases, administration of sedatives may be also associated with the risk of respiratory depression. Moreover, fiberoptic bronchoscopy or tracheal intubation while awake and spraying the local anesthetic agent over the vocal cords and pharynx may per se irritate the airway and cause severe coughs or may even completely obstruct the already constricted airway [8, 27, 28]. In our view, there is no definite safe solution for cases with both tracheal stenosis and difficult airway criteria. In these cases, both the anesthesia and the surgical team

should select the safest method possible for airway maintenance based on their experience and expertise and by close cooperation.

Cardiopulmonary bypass (CPB) has been used in cases with complete airway obstruction. Yang-Feng *et al.*, successfully established extracorporeal circulation through femoral artery and vein in 2 patients who required emergency resection and anastomosis of the trachea due to critical constriction of the lower trachea [16]. Availability of CPB at the time of anesthesia induction in cases with a severely constricted airway especially in lower tracheal stenoses seems logical for prevention of hypoxemia [3].

5. CONCLUSION

In severe tracheal stenoses, rapid intravenous induction of anesthesia is a suitable method for passage of rigid bronchoscop for dilatation of stricture. Careful planning and close cooperation of the anesthesia and surgical teams is critical for safe and successful conduction of this procedure.

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