A prospective study of the safety of tracheal extubation using endotracheal ventilation catheter in patients undergoing maxillofacial surgery

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ABSTRACT

الأهداف: اقتراح استخدام قسطرة تهوية الرغامى لنزع الأنبوب عن المرضى الذين يخضعون لعملية جراحية في الوجه والفكين.

الطريقة: أُجريت دراسة تم فيها إدراج 60 مريضاً ممن خضعوا لعملية جراحية في الوجه والفكيين، خلال الفترة ما بين سبتمبر 2004م وحتى أكتوبر 2006م، بمستشفى الإمام الخميني – تبريز – إيران. تم تقسيم المرضى عشوائياً إلى مجموعتين، احتوت كل مجموعة على 30 مريض. مجموعة التدخل، تم تركيب قسطرة تهوية داخل الرغامى قبل نزع الأنبوب. تم نزع الأنبوب عن المرضى في مجموعة التحكم كالمعتاد.

النتائج: تم ملاحظة انسداد مجرى الهواء العلوي لثلاثة مرضى من كل مجموعة، والذين تحسنت حالتهم مع التزويد بالأكسجين لدى مجموعة التدخل. كان معدل الازرقاق، تحرير التثبيت داخل الفك، والتنبيب الثاني لدى مجموعة التدخل أقل بشكل ملحوظ من مجموعة التحكم (p=0.021).

خاتمة: تعتبر قسطرة التهوية داخل الرغامى آمنة وسهلة لاستعمال الجهاز من أجل نزع الأنبوب، ويمكن المريض تحملها بشكل جيد. وعليه، نوصي باستخدام هذا النوع من قسطرة التغيير لنزع الأنبوب لدى المرضى الخاضعين لجراحة في الوجه والفكيين.

Objectives: To assess the use of endotracheal ventilation catheter for extubation of patients who underwent maxillofacial surgery.

Methods: Sixty patients who underwent maxillofacial surgery were enrolled in this study from September 2004 to October 2006 in Imam Khomeini Hospital, Tabriz, Iran. They were randomized to 2, 30-person groups. In the intervention group, endotracheal ventilation catheter was inserted before extubation. Patients of the control group were extubated routinely.

Results: Upper airway obstruction (stridor) was seen in 3 patients of each group, which improved with supplemental oxygen in the intervention group. The rate of cyanosis, release of intramaxillary fixation, and reintubation in the intervention group was significantly less than the control group (p=0.021).

Conclusion: Endotracheal ventilation catheter is a safe and easy to use device for extubation, and patients can tolerate it well. Therefore, we recommend the use of this type of exchange catheter for the extubation of patients undergoing maxillofacial surgery.

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Management of the airway is a continuum and included in the maintenance of intubation until the airway is safely extubated, and the patient no longer requires support. For most operating room patients, the likelihood of reintubation is in the order of 0.1-0.2%.[1,2] A difficult airway, as defined by the ASA Task Force, is the clinical situation, in which a conventionally trained anesthesiologist experiences difficulty with mask ventilation, tracheal intubation, or both.[3] Obviously in situations like difficulty with ventilation or initial endotracheal intubation, more attention should be paid at the time of extubation. Providing the secure airway in these patients can be extremely challenging, often resulting in considerable morbidity and mortality,[4,5] which results in death and brain damage in 85% of these patients.[6] A safe tracheal extubation strategy should also involve minimal discomfort, acceptable cost, and facilitate oxygenation and ventilation in a failing patient, even while the airway is being reestablished, and tracheal

intubation, if necessary.[4] Therefore, the anesthesiologist must formulate a plan of action to maintain, and then regain control of the airway if extubation fails. There are basically 4 approaches to extubation of the difficult airway: a) extubate conventionally while the patient is awake, b) extubate in a deep plane of anesthesia followed by the placement of a laryngeal mask airway, to decrease the risk of laryngospasm or bronchospasm, c) extubated over a flexible fiberoptic bronchoscope to observe the airway periglottic function, and d) awake extubation while maintaining continuous access to the airway with a catheter a bridge to full extubation. Fiberscope bronchoscopy can be very helpful for the patients suspected of having vocal cord palsy, and permits an assessment of anatomic injury to the trachea, glottis, or supraglottic structures.[7] Maintaining continuous access following extubation of a difficult airway via a hollow catheter, may offer connections with the option for jet and/or manual ventilation with oxygen insufflation. In most reports, tracheal tube exchange catheters are tolerated reasonably well by the vast majority of patients, and may be left in place for extended periods of time (1-24 hours),[8,9] if tracheal reintubation or a tracheal tube exchange is required. With the device in place, other options can be pursued including an evaluation of the benefits of helium/oxygen, or the inhalation of racemic epinephrine. Attaining satisfactory oxygenation (and ventilation), additional information, equipment, or expertise may be recruited. Maxillofacial and major neck surgery has a considerable risk for postoperative laryngopharyngeal edema and airway obstruction, due to prior surgical manipulation and hematoma.[10] Patients may develop laryngeal edema or airway obstruction culminating in reintubation after extubation. Reintubation may be very difficult or impossible through laryngoscopy because of mandibular fixation, or as a result of anatomical changes. Securing of a difficult airway with the use of alternative methods such as fibre-optic bronchoscope, retrograde intubation, or cricothyroidotomy may require considerable time and airway team effort. Providing a secure airway in these patients can be extremely challenging, and may result in considerable morbidity and mortality.[5] The aim of the study was to determine the clinical utility of maintaining continuous airway access post extubation, via an endotracheal ventilating catheter before tracheal extubation in patients undergoing major maxillofacial or neck surgery. Specifically, our aim was to determine if such a maneuver would reduce the likelihood of the hypoxemic event, while simultaneously maintaining the ability to reintubate the trachea.

Methods. Sixty patients admitted to our intensive care unit after maxillofacial surgery were extubated with the use of a endotracheal ventilation catheter (ETVC), were enrolled in this study conducted from September 2004 to October 2006 in Imam Khomeini hospital, Shiraz, Iran. This study was reviewed and approved by the institutional review board (IRB). Written informed consent was obtained from each patient. Exclusion criteria included cervical spine and upper airway trauma, cigarette smoking, morbid obesity, and a history of recent (2 weeks ago) upper respiratory tract infection. Tracheal extubation was considered when the patient met standard extubation criteria at our institution, was conscious, and capable of protecting the airway from aspiration, achieved stable hemodynamic state, and no longer required the endotracheal tube for pulmonary toilet under euthermic conditions. Patients were extubated when they had normal arterial blood gas (normal pH, normocapnia, normoxemia) with an inspired oxygen concentration of 0.4, a positive end expiratory pressure of less than 5 cm H_2O and pressure support of less than 8 cm H_2O. Patients were randomized (block randomization) to 2 groups: group I (control) patients were extubated conventionally without the ETVC to a facemask offering supplemental oxygen (6 L/m). For patients in group II (intervention), ETVC was inserted via the indwelling endotracheal tube, and then the patient was extubated leaving the ETVC in the intratracheal position via the nasal route, at the depth of approximately 27-30 cm at the nares. Following ETVC removal, the ETVC was secured with cloth tape wrapped around the patients' head to minimize the likelihood of dislodging it. Humidified oxygen was insufflated through the connector at the proximal port, at a rate of 6 l/min and titrated to keep the oxyhemoglobin saturation more than 90% (pulsoximetry). If the oxygen saturation decreased to less than 90% despite oxygenation, jet ventilation was applied with 25 psi pressure with a rate of 6 l/min, and inspiratory time of 0.5 seconds. The ETVC was removed when it became clinically apparent that the need for tracheal reintubation was unlikely based on criteria commonly practiced in our ICU. We considered the ability of patients to manage secretions including cough and swallow function in making the decision on extubation of ETVC. When patients failed to respond to the tracheal extubation, the catheter was used to facilitate reintubation. All patients were monitored with continuous pulsoximetry for oxyhemoglobin saturation and hemodynamic monitoring. Patients were observed for upper airway obstruction, releasing of intermaxillary fixation, reintubation, cyanosis (SpO_2<90%), and catheter tolerance.

Data were entered in SPSS statistical package (version 16.0) and analyzed with t test. A p-value <0.05 was considered statistically significant.

Results. The study population consisted of 60 patients who underwent maxillofacial surgery. Age ranged from 18-56 years. Demographic characteristics of patients were shown in **Table 1**. There were no significant difference between the 2 groups with respect to demographic data, duration of surgery, and pathologic condition. Following extubation, 3.3% of patients in the control group required reintubation, while no patients in the intervention group required reintubation (p=0.043). Upper airway obstruction (stridor) occurred in 3 patients in each group: each treated and responded successfully to intravenous lidocaine and nebulized epinephrine (2.25%), 0.25-0.5 ml as treatment. Two patients in the control group required intermaxillary fixation release, but no patients in the intervention group required this. Despite oxygen insufflation, 3 patients had cyanosis in the control group compared to just one patient in the ETVC group who received jet ventilation. So the rate of cyanosis, the need to release intramaxillary fixation, and reintubation in the intervention group was significantly less than the control group (p=0.021). The ETVC was left in the trachea for a mean duration of 1.5 hours (±34 min). The ETVC was tolerated in all patients. No increased incidence of coughing, excessive salivation, or other signs of airway irritation were noted with the indwelling ETVC. Chest radiographs to diagnose unrecognized complications and barotrauma failed to demonstrate evidence of trauma or aspiration.

Discussion. Tracheal extubation is the logical consequence of tracheal intubation and continued control of the airway after extubation constitutes part of overall airway management. To compliment this rational, it appears logical that a pre formulated extubation algorithm or plan be developed by practitioners managing such difficult airway patients. However, there is little in the anesthesia literature that offers distinct guidelines for the period during,, and immediately after tracheal extubation.[11] Problems associated with tracheal extubation can be separated into those occurring during ,or after extubation.[12] The extubation strategy of difficult airway should be adjusted to the type of surgery, the medical condition of the patient combined with the experience and preference of the airway management team. Complications associated with extubation are glottic edema, vocal cord malfunction,[13,14] and hemodynamic changes, macroglossia, acute pulmonary edema, aspiration, and upper airway obstruction may lead to concurrent impairment of oxygenation,[15] tracheomalacia, and laryngospasm.[16] Risk factors for failed extubation and difficult reintubation include difficult intubation, and requirement for additional airway devices during induction of anesthesia, development of airway problems since intubation, obesity, and a history of obstructive sleep apnea.[17,18] In certain settings, such as maxillofacial surgery, the risk of tracheal reintubation is increased. An indwelling airway exchange catheter (AEC) may justify an earlier trial of extubation without taking unnecessary risk, though the presence of an AEC does not guarantee successful reintubation of the trachea in the event of extubation intolerance. As prolonged intubation increases morbidity and cost, more frequent use of the AEC may be cost-effective by allowing earlier assessment of extubation tolerance. In patients with

Table 1 - Demographic data of patients.

Demographic data	Control group	Intervention group
Number	30	30
Age (years)	38 ± 18	34 ± 16
Weight (kg)	66 ± 17	70 ± 19
Gender (male/female)	16/14	17/13
Duration of surgery (min)	194 ± 37	183 ± 32
Traumatic/nontraumatic	26/4	27/3

Table 2 - Airway and respiratory complications after extubation.

Complications	Control group n (%)	Intervention group n (%)	*P*-value
Upper airway obstruction	3 (10)	3 (10)	>0.05
Releasing of intermaxillary fixation	2 (6.7)	0	0.021
Reintubation	1 (3.3)	0	0.043
Cyanosis*	3 (10)	1 (3.3)	0.010

*cyanosis is defined as $Spo_2 \leq 90\%$

Table 3 - Oxygen saturation (Spo_2) after extubation.

Time	Control group mean±SD	Intervention group mean ±SD	*P*-value
5 min	93.29±2.37	94.82±2.15	>0.05
10 min	93.81±1.88	94.65±2.36	>0.05
15 min	95.41±2.33	95.76±2.94	>0.05
30 min	96.32±2.64	96.51±2.47	>0.05

suspected or proven previous difficult reintubation, elective tracheotomy constitutes an alternative approach for maintaining airway access. However, tracheostomy is highly invasive and associated with potentially serious complications.[9] Prophylactic tracheostomy would unnecessarily expose patients to considerable risk.[19] Ventilating tube exchangers have been used to assist in the management of difficult airways in a variety of ways.[20] Various methods have been shown to facilitate the management of the airway in these patients, such as fiberoptic bronchoscope, an urgent cricothyroidotomy, or tracheotomy.[21] The ETVC offers several advantages over these alternatives: it provides a method for continuous administration of oxygen, it can be used as a stylet for tracheal reintubation, and it provides a method of ventilating patients (jet ventilation). Tracheal reintubation over tube exchanger is neither without complications nor 100% successful. Therefore, practitioners who use these devices should be familiar with such equipment, their potential complications, and alternatives in case of reintubation failure. Finally, the high-risk patients should be identified if possible. Moreover, a seasoned and experienced airway manager and nursing personnel should always be present for patient safety. Essential points for consideration include the security of connection, and the number of distal side ports (if jet ventilation is to be used), and the length of diameter of the device (particularly if the tracheal tube exchange is contemplated, or a double-lumen tracheal tube is involved). In general, the greater the diameter, the more alike is the device to a long tracheal tube, but the simpler it is to perform a tracheal tube exchange. Long devices with narrow inner diameters allow positive pressure ventilation, but offer high resistance. While such ventilation may be life saving, it may not be adequate for severely compromised patients that may necessitate jet ventilation delivered oxygen supplementation.[22] In a large prospective trial, Mort[23] showed that in experienced hands, AEC-facilitated reintubation is highly successful (93%), thus, the availability of alternative airway rescue devices and experienced airway team members is requisite for patient safety. The incidence of complications during AEC-facilitated reintubation is low, but nonetheless of a severe nature when difficulty re intubating the trachea is encountered. Incorporating an AEC-based extubation strategy does not necessarily reduce the reintubation rate, but certainly is a major step forward in maintaining continuous access to the airway following extubation. As demonstrated in Mort's study,[23] and appreciating that these patients had known or suspected difficult airways, the premature removal in the patient that becomes intolerant to the extubated state may lead to significant life-threatening hypoxemia, esophageal intubation, hypoxia induced bradycardia, and the need for an advanced airway technique to reestablish the airway. Mort[23] demonstrated that both the small (cook AEC, 3.7 mm outer diameter (OD) and medium (cook AEC, 4.7 mm OD) sized AEC are much better tolerated than the larger size AEC (cook, 6.33 mm OD) for extubation of trachea. Mort's[23] findings suggest that shorter stature patients (<65 in) tolerated the small AEC, as well as the taller counterparts tolerated the medium AEC. In our study, we did not have any complications, and the rate of reintubation decreased significantly. The high reintubation rate in Mort's study[23] (20%) is in contrast to the findings of our study, and 2 other previous studies using an AEC in a comparable patient population.[9,24] Many studies showed that AEC usage is a useful tool for extubation in patients with suspected difficult airway,[8,25] which is similar to our results. Care must be taken to avoid accidentally pulling the ETVC out when removing the existing end trachea tube (ETT). Properly securing the airway exchange (and ventilation) catheters at the same depth as the previously replaced endotracheal tube is imperative. In a study of patients requiring reintubation,[26] 87% of patients require reintubation within the first 4 hours following extubation. Loudermilk[24] reported a case of reintubation 48 hours following extubation. Mort[23] noted that more than one-half of the patients requiring reintubation of their trachea, did so 2 hours following extubation. Thus, the duration of maintaining continuous airway access via the AEC may be much longer than many clinicians anticipate. Premature removal of the airway catheter in the known or suspected difficult airway patient invites a management challenge. Mort's[23] paper reinforces that many patients require reintubation 4-24 hours following extubation, thus, it behooves the clinician to extend the duration of the indwelling airway catheter, especially in the patient with both a difficult airway and cardiopulmonary/metabolic/neurologic issues that may negatively impact extubation tolerance. In this trial, we did not have any airway obstruction in the intervention group, but we had 3 cases of airway obstruction in the control group, which all happened in the first 3 hours following extubation (**Table 2**). With insufflation of oxygen through ETVC, the rate of cyanosis was reduced significantly in this study, and because of possibility of jet ventilation in patients with ETVC, we did not have any reintubation in the intervention group. Before the use of ETVC in our hospital, we usually restricted extubation of patients who had undergone maxillofacial surgery and were at risk of difficult reintubation to the daytime, when experienced physicians were available, rather than during the night, to provide safer conditions.

In conclusion, as ETVC provides a means of ensuring oxygenation and ventilation, we suggest that after maxillofacial surgery, an ETVC be used routinely before tracheal extubation because it is difficult to predict which patients may require reintubation.

References

1. Emery SE, Smith MD, Bohlman HH. Upper-airway obstruction after multilevel cervical corpectomy for myelopathy. ***J Bone Joint Surg Am*** 1991; 73: 544-551.
2. Biro P, Priebe HJ. Staged extubation strategy: is an airway exchange catheter the answer? ***Anesth Analg*** 2007; 105: 1182-1855.
3. Caplan RA, Benumof JL, Berry FA. Practice guidelines for management of the difficult airway. A report by the American Society of Anesthesiologists Task Force on Management of the Difficult Airway. ***Anesthesiology*** 1993; 78: 597-602.
4. Bedger RC Jr, Chang JL. A jet-stylet endotracheal catheter for difficult airway management. ***Anesthesiology*** 1987; 66: 221-223.
5. Rudra A, Chatterjee S. Tracheal extubation in the difficult airway. ***Indian Journal of Anaesthesi***a 2006; 50: 430-434.
6. Caplan RA, Posner KL, Ward RJ, Cheney FW. Adverse respiratory events in anesthesia: a closed claims analysis. ***Anesthesiology*** 1990; 72: 828-833.
7. Cooper RM. The use of an endotracheal ventilation catheter in the management of difficult extubations. ***Can J Anaesth*** 1996; 43: 90-93.
8. Wise-Faberowski L, Nargozian C. Utility of airway exchange catheters in pediatric patients with a known difficult airway. ***Pediatr Crit Care Med*** 2005; 6: 454-456.
9. Dosemeci L, Yilmaz M, Yegin A, Cengiz M, Ramazanoglu A. The routine use of pediatric airway exchange catheter after extubation of adult patients who have undergone maxillofacial or major neck surgery: a clinical observational study. ***Crit Care*** 2004; 8: 385-390.
10. Halfpenny W, Mc Gurk M. Analysis of tracheotomy associated morbidity after operations for head and neck cancer. ***Br J Oral Maxillofac Surg*** 2000; 38: 509-12.
11. Asai T, Koga K, Vaughan RS. Respiratory complications associated with tracheal intubation and extubation. ***Br J Anaesth*** 1998; 80: 767-775.
12. Hartley M, Vaughan RS. Problems associated with tracheal extubation. ***Br J Anaesth*** 1993; 71: 561-568.
13. Chaten FC, Lucking SE, Young ES, Mickell JJ. Stridor: intracranial pathology causing postextubation vocal cord paralysis. ***Pediatrics*** 1991; 87: 39-43.
14. Pfenninger J. Bilateral vocal cord paralysis after severe blunt head injury-a cause of failed extubation. ***Crit Care Med*** 1987; 15: 701-702.
15. Tolley NS, Cheesman TD, Morgan D, Brookes GB. Dislocated arytenoid: an intubation-induced injury. ***Ann R Coll Surg Engl*** 1990; 72: 353-356.
16. Rex MAE. A review of structural and functional basis of laryngospasm and a discussion of the nerve pathway involved in the reflex and its clinical significance in man and animals. ***Br J Anesth*** 1970; 42: 891-898.
17. Peterson GN, Domino KB, Caplan RA, Posner KL, Lee LA, Cheney FW. Management of the difficult airway: a closed claims analysis. ***Anesthesiology*** 2005; 103: 33-39.
18. Crosby ET, Cooper RM, Douglas MJ, Doyle DJ, Hung OR, Labrecque P, et al. The unanticipated difficult airway with recommendations for management. ***Can J Anaesth*** 1998; 45: 757-776.
19. Hartley M, Vaughan RS. Problems associated with tracheal extubation. ***Br J Anaesth*** 1993; 71: 561-568.
20. Rosenbaum SH, Rosenbaum LM, Cole RP. Use of the flexible fiberoptic bronchoscope to change endotracheal tubes in critically ill patients. ***Anesthesiology*** 1981; 54: 169-70.
21. Ezri T, Katz J, Szmuk P, Warters RD, Geva D. Use of a ventilating tube exchanger in patients undergoing tracheostomy: report of two cases. ***J Clin Anesth*** 2001; 13: 125-127.
22. Cooper RM , Coher DR. The use of endotracheal ventilation catheter for jet ventilation during a difficult intubation. ***Can J Anesth*** 1994; 41: 1196-1199.
23. Mort TC. Continuous airway access for the difficult extubation: the efficacy of airway exchange catheter. ***Anesth Analg*** 2007; 105: 1357-1362.
24. Loudermilk EP, Hartmannsgruber N, Stoltzfus DP. A prospective study of the safety of tracheal extubation using a pediatric airway exchange catheter for patients with a known difficult airway. ***Chest*** 1997; 111: 1660-1666.
25. Moyers G, McDougle L. Use of the cook airway exchange catheter in bridgingthe potentially difficult extubation: a case report. ***AANAJ*** 2002; 70: 275-78.
26. Listello D, Sessler CN. Unplanned extubation: clinical predictors for reintubation. ***Chest*** 1994; 105: 1496-503.

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